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THE STATE BUILDINGS OF MISSISSIPPI AND WEST VIRGINIA AT THE EXHIBITION.

In the Mississippi State Building the natural and industrial products of that State are well represented. The structure is one of the most unique on the grounds. It is a log-cabin, and every foot of timber used in construction was shipped from Mississippi. Carpenters from that State were sent to erect it. With its walls of native wood, fresh from the forests, its rustic framed windows, Gothic doorway and overhanging eaves fringed with moss; its balconies of naturally and curiously carved roots and limbs, and its numberless reminiscences of the untrodden forest, it forms one of the most interesting, if not the most instructive, State Buildings on the grounds. There are in the superstructure sixty-eight different kinds of woods, not including the door-panels, which are made of forty-eight different varieties. The outside walls are chiefly of hickory, and split logs with the bark on, while the door and window-frames are made of many varieties of pine. The entire structure is rich with ornaments found carved by nature in Mississippi forests, while the inner walls are of finely polished specimens of every variety of pine. Some of these resemble bird's-eye maple in their delicate, rich vein tracings, and others, from the heart of the tree, are almost as dark and brilliant as mahogany. The porticoes on both sides are ornamented with mosses, while from the arched verandas are pendent beautiful hanging baskets.

The West Virginia Building is located near the State structure of Mississippi, on the eastern slope of George's Hill. The portal bears the cosmopolitan announcement that West

THE MISSISSIPPI STATE BUILDING.

Virginia welcomes everybody. The structure covers about half a rood of ground, or about four times as much as that taken by the Mississippi Building. It is composed entirely of wood, representing many native varieties. The plot of ground surrounding it is studded with a score of rectangular blocks of bituminous and semi-anthracite coal, some of them being solid masses ten feet high and four feet square at the base. These stand like sentries upon which the building relies for protection, just as the State does upon the mineral supply, which they represent, for her greatest natural source of wealth. The display within the building is mainly of petroleum in its various stages, sections of gigantic timber, and specimens of school-children's work. Some of the examination papers shown were prepared upon such subjects as geometry, natural philosophy and algebra by children only twelve years of age, and would be quite creditable to freshmen in many colleges. But the most admirable feature of the educational display are the crayon drawings. These are chiefly of the human head in varying profiles, and combine delicacy of touch with accurate delineation.—*Frank Leslie's Illustrated Newspaper.*

THEORELL'S PRINTING METEOROGRAPH.

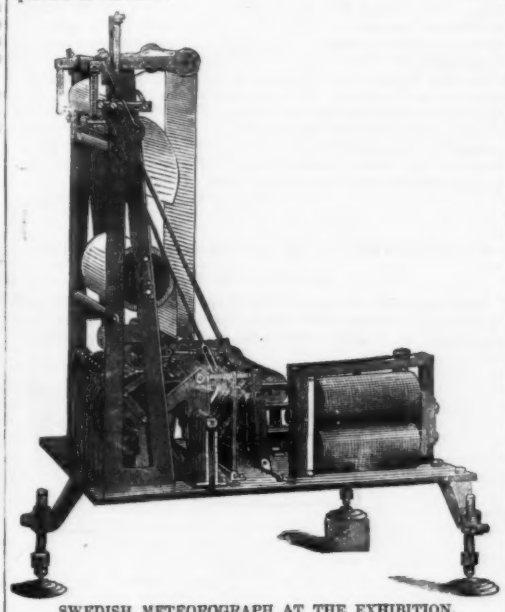
THIS beautifully designed and constructed recording apparatus is in constant operation at the Swedish school-house, Centennial Exhibition. The thermometers, barometers, anemometer, etc., are in a specially-constructed building near the school-house, in a location not well adapted for accurate registry of wind force and direction. Due credit should be given Mr. Sörensen for the exquisite workmanship of the apparatus, which was set up by himself.

The following description is that prepared in Stockholm for the constructor:

"Meteorological observations are shown by this instrument on tables printed on a slip of paper. Of the six tabular columns, the first gives the hours; the second, the velocity of the wind; the third, the direction of the same; the fourth, the temperature; the fifth, the degree of humidity, according to August's method; and the sixth, the atmospheric pressure, which is given in millimetres. The degrees of the thermometer employed are those of the centigrade scale, and negative degrees are expressed by their complements of 100. The direction of the wind is indicated by figures from 1 to 2. The numbers expressing the velocity of the wind signify metres in a second.

"The registration takes place by means of electrical currents, which are closed in the barometer and both the thermometers by contact between the quicksilver and steel wires that descend into their tubes, and at the weather-cock and anemometer by contact between a metal knob, which is put into motion by the current, and a wheel, which is in a direct mechanic combination with each of these instruments.

"The steel wires in the barometer and in both the thermometers are connected, each by its respective system of brass wheels, with numerical types engraved on the edges, in such a manner that the rotation of the wheels causes an upward or downward motion of the steel wires, so that the point of the scale on which the lower extremity of the wire is situated is necessarily that indicated by the number appearing at the same moment uppermost on the corresponding wheels. The two other brass wheels with engraved figures are likewise combined, by means of electric currents, with the above-named metal knobs in the weather-cock and the anemometer, in such a manner that the figure which is uppermost on the periphery of the wheels at the moment it is about to be registered indicates the direction of the wind at the same moment, and its mean force during the preceding quarter of an hour.



SWEDISH METEOROGRAPH AT THE EXHIBITION.

"The wheels containing the figures are governed by an electro-magnetic motor, which for each observation sets the five systems successively in motion until the corresponding wires have reached the quicksilver in the barometer and the two thermometers, and caused a contact between the above-named metal knob in the weather-cock and the anemometer, and the wheels, which are in a mechanical combination with each of these instruments.

"The numbers, therefore, that are uppermost on the numbered wheels are just those which indicate the height of the barometer and of the two thermometers, as well as the direction and the velocity of the wind. And now the same electro-magnetic motor operates upon a printing apparatus, which, after having deposited color on the types, presses the above-mentioned slip of paper against them.

"This being done, the steel wires are drawn up again by the motor, which stops as soon as a certain distance from the quicksilver is attained, and all is ready for the next observation.

"The interval between the observations is a quarter of an hour.

"A meteorograph of this construction has now been used at Upsala Observatory for two years, and during that time it has made four observations every hour, without causing any perceptible change in the surface either of the quicksilver or the steel wires that could in any way affect either the free efficiency of the instrument or its degree of accuracy, which, throughout the whole time, has been found to be as above stated.

"As the clock which determines the time of the observations does not require winding up, the instrument itself restoring the tension of the mainspring every quarter of an hour, it continues going as long as the impellent force, *i.e.* the electric current, is maintained; and as the slip of paper applied lasts for fully three months, that is the period for which the instrument may be left to itself."—*Polytechnic Review.*

THE FRENCH EXHIBITION OF 1878.

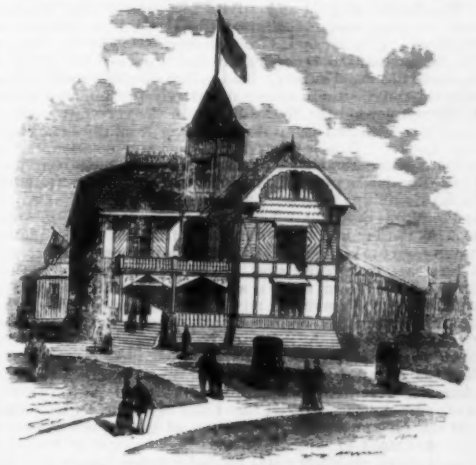
THE Commission Supérieure of the Paris Exposition of 1878 has decided upon the general plan of the enterprise, and estimated the probable receipts. The expense is set down at 35,000,000 francs, and the receipts at 19,000,000; difference, 16,000,000 francs. To meet this deficit, the city of Paris will contribute 6,000,000 francs, and the state 10,000,000 francs. The buildings for the exposition will be erected in the Champ de Mars and in the Trocadero—localities situated on opposite banks of the river Seine.

THE GOLD AND SILVER DISPLAY.

"THERE has never been so fine a collection of minerals on this globe," said one of the judges of Group I in reply to my inquiry as to how the Centennial Exhibition compared with its predecessors. This was said enthusiastically; and is the opinion of an expert, as Group I has to do with metals and minerals. It is not only the largest and most varied collection; it is the choicest as to specimens and the most instructive in the completeness of its range. It is quite practicable to study out here, without stepping out of the Centennial grounds, the entire geological and mineral characteristics of several European countries, of most of the English colonies, and of a number of our own States. The collection is equally great in mineral specimens, in cut and polished products of the quarry—monuments, ornamental stones, and the like—and in the display of metals shaped to the various needs of industry or taste. But as each of the Centennial buildings and each of the annexes has its contents arranged by countries and States, it follows that the exhibition of metals and minerals, marvellous as it is, fails almost wholly of an effect on the observer, since it is practically scattered about among other things and over several acres. Even if every building were thoroughly explored, the visitor who attempted a complete survey would find in addition a large number of noteworthy displays of minerals and monuments out of doors.

BRITISH COLONIAL GOLD.

Even a careless observer can not overlook the displays from the gold and silver producing countries. The British colo-



THE WEST VIRGINIA STATE BUILDING.

nies each show their separate amounts of gold obtained since its discovery on their soil, by a very striking device—a gilded pyramid, whose bulk exactly equals the total of gold for each colony. Aside from its effectiveness as a popular display, this is of real service; it gives at once the idea of the total as well as the relative product. Most Americans have a general impression, for instance, that the discoveries of gold on Fraser River and elsewhere in British Columbia amounted to very little; but here is the evidence to the contrary in a gilt pyramid indicating that the total of gold there found from 1858 to 1875 was nearly $38,000,000. It is much to be wished that a similar method had been carried out for each of our own States and Territories. The eye is better able to judge quickly of dimensions than of figures, and the impression thus made in comparison of bulks by sight is more permanent and instructive. The specimens of gold ores from each of the Australian colonies and from British North America give in each instance a complete series, and the great nuggets are also represented. The processes of obtaining the gold, and the localities where it is found, are shown by photographs. Of course the great exhibits are from Australia. Among the minor ones of interest, Nova Scotia sends beautiful specimens in the rock, which will convince even the incredulous as to the gold in that province; the amount obtained there from 1862 to 1875 was over 242,000 ounces.

SILVER EXHIBITS.

In silver the foreign display is less striking, but from a wider range. Canada sends a fine array of specimens from the Lake Superior district; of these the best are from Major A. H. Sibley, of New York, representing the ores of Silver Islet, which has produced up to the present date about $2,500,000 worth of silver. Skipping for the present our own country, and following the silver-beds southward, we have next the great display of Mexico, which includes a fine series of silver ores and an immense mass of the metal itself, the latter being one of the remarkable things in the Exhibition. All the foregoing displays of precious metals are in the Main Building. Among the curiosities in the Government Building is a fine specimen of ruby silver from Chihuahua. Going still southward, the silver-beds of this hemisphere dip beneath the sea till we reach South America. From that continent Chili sends by far the most interesting exhibit of silver. The series of ores is quite complete, several mining districts being fully represented, especially that which contains the famous mine of Chañarcillo. The cabinet of Emilio Escabar attracts much attention from mineralogists. The most striking feature of the Chilian exhibit is the ruby silver in beautiful crystals. "As far as appearance

goes, they would fairly deserve to rank with jewels, but they are unfortunately too soft to be set and worn as gems. It is very unusual for a crystalline mineral which must stay locked in a cabinet to have such a value as this; but such is the rarity of fine ruby silver that one of these specimens is valued at $4000. Chemically it is the antimonial sulphide of silver; as a mineral its name is proustite. In a separate building entirely devoted to the purpose, Chili shows the machinery and processes of amalgamating and extracting silver. The exhibit is a working model on a linear scale of 1 to 6 (cubic proportion, 1 to 216). Two finely finished steam-engines, neat and very small, form part of the model, and actually drive the machinery. I hear that there is much curious speculation as to the object of this exhibit. People of a practical turn of mind, who have noticed that the buildings devoted to separate industries are little else than gigantic advertisements, ask what is the purpose of this separate show of amalgamating machinery from Chili. A suggestion that the amalgamation may have a dark political intent probably has originated with Democratic visitors who are not aware that the Chilians are quite as "Caucasian" as they.

SOUTH AMERICAN GOLD AND SILVER.

While neither the Peruvian nor the Brazilian show of precious metals calls for special remark, it is worth noticing that the latter is much the greater. It justifies the belief that Peru has lost rank among the silver-producing countries, but it may be the mere accident of inferior exhibition The Argentine Republic makes good its name by sending not less than 225 specimens of silver ore. The examination of these is much facilitated by the special catalogue of that country. They are of considerable commercial value, and include many that are curious. Among them are three or four illustrations of ruby silver in crystalline form. There are also 25 or 30 specimens of ore containing gold.

EUROPEAN EXHIBITS.

From the Old World there are specimens of the gold of the Ural Mountains in the Russian exhibit, a very considerable display of silver and its ores from Spain, and of gold and silver from Portugal. But Norway's show of silver is the most noteworthy, the Konigsberg Silver Works making an exhibit in the Main Building which, like every thing else from Europe's northern peninsula, is admirable. Both ore and ingots are shown, as well as the metallurgic processes, and not the least curious part of this exhibit is a specimen of the overlying rock veins, including flat crystals which stand apart on their edges and inclose geometrical spaces.

AMERICAN GOLD AND SILVER.

The display of gold and silver from the United States is very rich, but under the great disadvantage of being much scattered. I do not feel sure of doing it justice, as some of the exhibits are so tucked away that they are not likely to be found in a rapid survey. In the Main Building and its two mineral annexes there are comparatively few minerals of any kind from beyond the Mississippi. In the very full series of ores from Michigan there is some silver from the Lake Superior district. This is deserving of separate mention, not on account of the abundance or size of the specimens, but from their singular character. The brightest, whitest native silver in the Exhibition is to be found here—in the Mineral Annex to the Main Building. These specimens of Michigan silver look as if they had been deposited from an electro-plating battery, and it is likely that they are a product from galvanic action that took place ages ago in the soil; some of them have leaf and fern shapes, and are mounted on copper of equal purity. Where the silver and copper join the metals are welded together, and though the line of demarcation between them is plainly indicated by the respective colors, the junction is as perfect as if they were one piece of metal. Yet there is no alloy between them. When specimens of this character were first found, Profs. Foster and Whitney—who were preparing a report on the Lake Superior region, which has since become one of the classics of geology—sent some of the specimens to a distinguished mineralogist at Freiburg The German professor could not believe that pure copper and silver were thus associated in nature, and at once denounced the whole thing as a Yankee trick. Among the fine illustrations in the Mineral Annex of this curious combination is a set of miniature models of the tools used in mining, each of which is made of the two metals thus naturally joined in two or three places in each tool. Thus half an inch of the handle of a pick is a rod of silver; the next half inch is copper; part of the head of the instrument is silver again, and the rest is copper; but the apparent texture is uniform throughout, as if the whole were of one metal.

GOLD ORES.

The gold ores in the Government Building representative of Georgia's mineral wealth are more numerous and noteworthy than from Virginia or North Carolina. The rest of the gold and silver specimens from the Eastern, Middle, and Southern States are of no importance except as objects of curiosity. But the mining States and Territories of the West make up for all deficiency elsewhere by the abundance of their display. Only a small proportion of this is to be found in the Main Building and its two mineral annexes. The more interesting and rare specimens are chiefly of silver ores. There is a building separately devoted to an exhibit of the stamping and crushing machinery of the Nevada silver mines. This is furnished by four of the mining companies. It is not in miniature like the Chilian machinery. The heavy stampers do full-fledged work on the ores provided, with the normal amount of noise; and the triturated mass is duly stirred with great commotion in a large tank of water. Moreover, the visitor can here buy silver medals guaranteed as to purity of metal and made—so far as the extraction of silver is concerned—by the processes which he witnesses; the medals are coined at the mint. To find the largest exhibit of gold specimens we must go to the Government Building, where there is a neat little show of them kept in an iron safe. This includes some crystalline specimens of notable beauty, and a neat but not very large display of the metal itself in various conditions, fairly illustrative of the forms in which gold is discovered. The gold display from Virginia City is especially showy. The First National Bank of Helena lends specimens of gold dust, nuggets, and quartz. In separate cases in the Government Building, each of the Western mining States and Territories presents a series of its ores containing precious metals. Nevada has a full set of specimens from the Comstock lode, and shows gold as well as silver. In the California cabinet there are several specimens where the gold crops out to view on the edges and in the seams. The Montana case is singularly rich in crystalline forms. Especially interesting to the mineralogist are the tellurium ores which Colorado exhibits. Tellurium is a queer substance belonging to the sulphur and selenium group of metalloids, and somewhat rare; in fact, it has been ever since its discovery a sort of chemical curiosity. This is the substance of which a certain professor ate a small quantity, and noticed with surprise for several days afterward that his friends avoided him. Finally one of them, getting to the windward and burying his nose in his handkerchief, kindly explained to the professor that he exhaled a horrible smell. The professor's friends might have been reconciled to his scent if they had known that thousands of dollars' worth of gold were to be discovered in conjunction with tellurium This remarkable association was first discovered in the locality made famous by Bret Harte's poem—on the banks of the Stanislaus River in California. The telluric ores from Colorado shown in the Government Building come from two different localities in that Territory, now a State: one in its south western portion, the other more nearly central, and south of Denver. Some of these ores are very rich, yielding $50,000 of gold to the ton. The casual visitor will be apt to miss a fine collective exhibit of minerals gathered on the line of the Central Pacific Railroad, as these are in cases in the Agricultural Building. They include many fine and valuable specimens of silver ore. To see all that the Western mining districts have sent it will be needful also to take a glance in the buildings of the States and Territories.

SILVER ORES.

It may be noticed that the variety in silver ores as represented in the Exhibition is far greater than of gold. This is not to be ascribed to the circumstance that silver is more plentiful or more widely distributed than gold, but rather to the chemical nature of silver itself. It is more ready to enter into combinations. The most natural of these and the one which is most abundant, if indeed it is not the primal one from which all or nearly all the others are formed, is the black sulphide of silver. This, meeting with water charged with different salts, or in drier situations exposed to atmospheric influences, undergoes various changes, some of which are immediate substitutions, while others are consecutive. The first step is frequently oxidation from sulphide to sulphate. In case of "ruby silver," antimony has taken the place of part of the sulphur. In "horn silver," the chlorine has doubtless been supplied from salt water, producing a tough substance, usually in coatings and sheets that cut like wax. The iodide and bromide ores are of course the result of similar processes. Some of these changes are actually going on at the present day in the Comstock mines, evolving a temperature there which is frightful to contemplate even after the heated term of this summer. The miners there have to be kept wet with streams of cold water, and even with this advantage can not work in the hottest seams for more than an hour or two at a time. This heat is the direct product of chemical action. It should furnish a strong argument to the more modern theory of volcanoes, which dispenses with belief in the central fires of the globe.

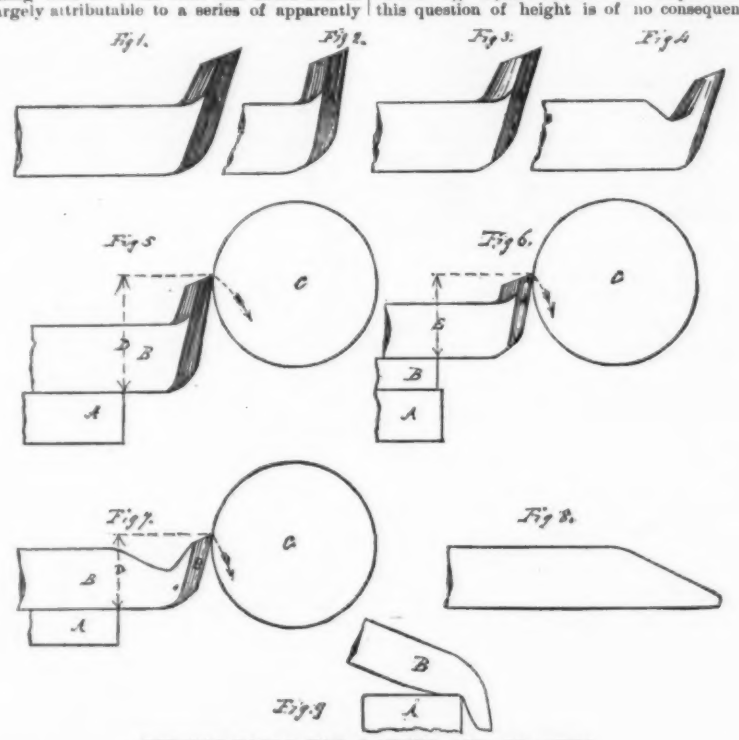
W. C. W. in *N. Y. Tribune.*

CUTTING-TOOLS FOR LATHES AND PLANERS.

By JOSHUA ROSE.

THE variation in the amount of duty obtained by different workmen operating with the same tools and under similar conditions, is largely attributable to a series of apparently minor matters which form in the aggregate the considerations which determine of themselves the capacity of the tool, while the ability to perceive and take advantage of them it is in which constitutes what is commonly credited to manual dexterity. In working a lathe or planer there are but three main considerations: the first is how to chuck or hold the work, the second is of what shape to make the tool, and the third is the feed and speed at which to cut the metal. This last consideration is, however, in the case of planing confined to the question of feed, since those machines have usually a fixed rate of cutting speed, ranging between 24 feet for small and 12 feet per minute for large planers. Both in the lathe and planer, especially in the latter, however, the amount of feed possible, as well as the cutting speed, is largely dependent upon the shape of the cutting-tool—that is to say, the shape of its outline independent of the particular angles whose junction forms the cutting edge, as well as irrespective of the angle at which the top face of the tool meets the line of severance of the cuttings. Machinists should, whenever it is practicable, forge their own tools, because there are often fine points in the shape, angle, and bend of a tool which it is impracticable to describe to a blacksmith, and exceedingly difficult to represent in a sketch, even were the operator skilful enough to make one. The writer had one of the commonest lathe-tools in use forged as a guide for the draughtsman to sketch from, but it was found impracticable by the most expert draughtsmen or artists to illustrate the most important view of the tool, and the attempt was finally abandoned. Thus it happens that the form of tools is often left to the blacksmith, who can form no accurate idea of the precise shape necessary for a particular tool. To him all boring tools for iron are the same, and all boring tools for brass are identical so far as general outline is concerned, and the apprentices accept those forms thus given to them by the blacksmith as authoritative, and get the most duty they can out of them. In the course of years an apprentice discovers for himself the necessary variation of form for different conditions, and becomes an expert by simply avoiding blunders transparent after a moment's intelligent consideration.

A visit to the American Institute Fair, the Cincinnati or Franklin Institute Exhibitions, or to the Centennial Exhibition, is all that is necessary to a demonstration of the correctness of these statements. At such exhibitions we might naturally expect to find the best of practice, but such is far from being the case. The form of tool which is most frequently found in use is that shown in Fig. 1, which is deficient in every essential element. In the first place it is difficult to forge, and during that process the grain of the steel is considerably upset, which deteriorates it. In the next place, it is exceedingly difficult to grind because of the tediousness of the operation, which arises from the length of the face A presenting so much surface requiring to be ground away. Fig. 2 is a similar tool made of the most favorable form in which such a tool can be made for use in a planer, the difference being that the face A in Fig. 2 is much more nearly vertical than the face A shown in Fig. 1. Figs. 3 and 4 represent a similar class of tool swaged or forged round, entailing unnecessary labor without possessing any advantage whatever. We now come, however, to the main objection to this class of tool, which is illustrated in Fig. 5, in which A represents the top face of the slide-rest, B the tool, and C a piece of work held between the lathe-centres. Now it is obvious that the height of the cutting edge of the tool from the bottom of the tool is regulated to a great extent by the distance between the top face A of the slide-rest and the horizontal centre of the lathe centre as represented by the dotted line D. It is desirable in all cases to make this height as small as consistent to admit tool steel of sufficient strength, because the greater the height the greater the tendency of the tool to spring into the work, and the direction of the tool-spring, as denoted by the arrow, is more to cause the tool to enter deeper into its cut at those parts of the work where the cut is heaviest; or if the work has hard and soft seams, or spots in it, the tool will follow them, producing work that is not round or true. To obviate this defect in lathes having an undue amount of distance between the distance from the top of the tool-rest to the horizontal centre of the lathe-centres, a packing-piece formed of a strip of metal is sometimes interposed between the tool and the face of the rest as shown in Fig 6, in which *a* represents the top face of the slide-rest, B the packing-piece referred to, *c* the work, and E the height from the bottom face of the tool to the cutting edge, which is in this case very much reduced. It will be observed, however, that in this latter case the tool, being short, will soon require reforging, or drawing out, as it is more commonly termed. In a planer this question of height is of no consequence except in so far as it relates to the spring of the tool, in which it is, however, of the utmost importance, especially when operating upon light work, or when using a slight tool, particularly if the tool requires to stand with the cutting edge at a comparatively great distance from the tool-post. From these considerations, tools of such a form are to be utterly condemned for any purposes whatsoever. The proper form of tool for use in both lathe and planer is that illustrated in Fig. 7, in which figure A represents the face of the slide-rest, B the tool, C the work, and D the height from the bottom of the tool to the cutting-edge. Here we find the distance D to be small, the direction of the spring of the tool to be not so much in a line as to affect the work, and the face E of the tool not so long as to involve any undue amount of labor in the grinding operation, while at the same time it is a form the easiest of all to forge, requiring no upsetting during the forging operation, and being easy to handle. It will do more work in a given time than any other, and perform it more true, the difference in this latter respect being great, especially in cases involving conditions liable to spring. It will take a depth of cut altogether unattainable with any other form of tool, and may be made for all purposes as hard as fire and water will make it, requiring in no case to be tempered. On small work it may be used at a cutting speed as high as 35 feet per



CUTTING-TOOLS FOR LATHES AND PLANERS.

minute with a feed of 20 to an inch, and is equally applicable to cast-iron, wrought-iron, steel, or copper. To forge it the steel is drawn down as shown in Fig. 8, and the end is bent up over the corner of the anvil as shown in Fig. 9, in which A represents the anvil face, and B the tool.

BUILDING ASSOCIATIONS IN PHILADELPHIA.

A PAPER full of information in regard to the co-operative banks of that city, commonly known as "Building Associations," was read at the Social Science meeting in Philadelphia, in May last, by Mr. Joseph I. Doran, a young lawyer, who had the court records and the mortgage registers searched to see how extensive and how safe such associations are in Philadelphia. He estimated their number in active operation at 450; the number of their members at more than 60,000; the monthly payments by shareholders at more than $650,000, and the amount of real estate on which they hold mortgages at from $60,000,000 to $75,000,000 in the city of Philadelphia alone. The average number of members in each association, Mr Doran thinks, is 150; the average time in which the shares reach their par value is ten years. They now hold nearly one third of all the mortgages yearly made in Philadelphia, and the proportion of foreclosures upon property of this sort is but little more than half as great as upon other mortgaged property.

In short, Mr. Doran demonstrated by figures that these co-operative banks have flourished, multiplied, and greatly benefited their shareholders, who have thus become the owners of over 30,000 homes during the twenty-six or seven years that these associations have been growing up to their present magnitude. This was done concisely, and in such a way as to make a much deeper impression than argument or panegyric could have effected; and the debate which followed the reading of Mr. Doran's and Mr. Wrigley's papers are equally conclusive as to the firm hold obtained by these peculiar associations in Philadelphia. One of the most eminent judges of the city said that in his ten years' experience on the bench, he had heard of only two cases of peculation by the officers of these banks, one of which came before him as judge. This is a better record than even the savings-banks of New England have to show. Mr. Henry C. Carey remarked to one of the speakers that his native city had one distinction not enjoyed, so far as he knew, by any other great city in the world—that it contained at least 50,000 dwelling-houses, each with a private bath-room.

A NEW ROAD PAVEMENT.

By M. K. COUZENS, Civil Engineer, Yonkers, N. Y.

ONE of the greatest engineering requirements of the present time is a complete system of road construction in cities and populous places.

Examinations and reports, by boards of engineers, park and road commissioners, for many years past, in Europe and America, lead to the conclusion that the perfect city pavement has yet to be laid.

It is hardly a query, whether the manifold failures of patent pavements in our large cities, especially the imitation asphalt, are not in most cases due to the ignoring of professional talent, and the co-operation of official venality with ignorant and unscrupulous contractors, producing hasty work with apparently well-finished surfaces, then quick drafts upon the public treasuries, with no care or concern what thereafter becomes of the work. Indeed, it is a lamentable fact that most mechanical work has greatly declined in character with us in the last twenty-five years, but none seems to be so much slighted as this species of work.

A practical experience in road-making in this country, with considerable study and observation abroad during twenty-five years past, has led the writer to the following conclusions. That the several conditions of a good city pavement are:

1st. A well-drained, unyielding foundation.

2d. A durable surfacing material, not liable to polish, of least traction or wear to man, horse, and vehicle.

3d. Accessibility to street mains with least loss of material in taking up and replacement, with immediate and equal strength of the restored pavement to the adjacent undisturbed road. And,

Generally, comparative economy of construction and maintenance, neatness of finish, least amount of mud and dust, cleansing facility, and, not of least importance, sanitary character.

Questions of detail, such as maximum grades and lines of cross section, nature, form, and chemical character of the constituent materials, the preparing and placing apparatus, and methods of handling, are each of the first importance to secure a perfect result.

The unalloyed asphaltic rock or bituminous limestone, so largely in use in Continental cities of Europe, and considerably in Great Britain, is beyond doubt the best surfacing material known. A very few of the hundred and odd patented compositions approximate thereto in value, but millions of dollars have been wasted on the rest of the lot.

The Paris engineers have recently determined that, after twenty years' use in heaviest traffic of asphaltic pavement in their city, the loss of abrasion is nearly nothing. Indeed, the slight decrease in thickness of the asphalt coating after so long a use may be due entirely to vehicular compression. The macadam of hard Aberdeen granite on London Bridge required five inches in thickness for annual replacement. This lasting property of the genuine asphalt is truly wonderful. No mud or dust is generated by attrition, and no clogging of basins and sewers can arise therefrom. There are no joints or cracks for deposition and retention of fermentable matter to poison the atmosphere. While vehicles roll along noiselessly, crossing pedestrians are warned by the resonant audible tramp of the horses' hoofs. A slight but agreeable smell is emitted in high temperatures, said by medical authority to add to its superior sanitary character. Actual observation upon easy similar grades shows that more horses fall on other pavements than on asphalt roads. Repairs are made by simply cutting out any damaged portion and replacing with hot asphalt. In regard to expense, the present cost in London and Paris is from $2.80 to $3 per square yard; annual repairs in general, 25 cents per yard. A similar pavement here would cost near fifty per cent more. One half at least of the total expense there is for the raw asphaltic rock delivered on the ground.

But the third condition above noted has not been complied with in European road constructions. Wherever replacement after trenching has been done, the concrete bottoming and asphaltic covering is lost, and also several days' obstruction occurs from greenness of new bottoming, and the restoration is invariably imperfect; requiring from time to time further expense. And the concrete bottoming, usually about three inches in thickness, by compacting and rolling becomes so smooth on its surface that there is but little grip for the asphalt covering, therefore requiring at least double the thickness of the costly asphalt to prevent lesion, during low temperature, by roof percussion. Now, with hard bottoming, slightly and regularly indented, or semi-serrated, transversely to the line of road, and the asphalt compacted thereon, a much firmer roadway, less liable to mechanical or atmospherical disturbance, would result, and not more than one half of such expensive covering material would be necessary, producing a saving in this country, on this item alone, of at least thirty per cent of the cost. Further, the loss of material in replacement, and the reduction of the cost of annual repairs added to the above economical consideration, points to the remedy I now proceed to suggest, of using moulded blocks of artificial stone, formed under hydraulic pressure, indentate or serrate on the surface with interlocking edges, so as to form when the work is complete a solid arch from curb to curb, thus widely distributing the passing load. The hexagonal form of block, 1 foot wide and 4 to 6 inches thick, three of the edges slightly convex and three concave, is the strongest form without interstitial spaces; the bottom of block slightly convex, and to prevent upward absorption, the bottom surface and lower edges to be dipped, before laying, in hot liquid bitumen. The sand foundation to be machine-rammed from 2 feet below to about an inch above the needed surface, and then with cutting-machine formed truly parallel to the intended lines of finish, so as to present an equal bearing for the blocks in all parts of the way. The gutter-blocks to be 2½ inches thicker, and every tenth or twenty-fifth gutter-block to have a square instead of convex edge, with an inch hole through for tool insertion and lifting when and where trenching is required. A cutting-tool of same size and pattern as the blocks, to heat and cut through the asphalt at the joints without injuring blocks or covering, so that on replacement by number the only material required is some liquid bitumen or mastic poured into the joints and ironed off, after the reset blocks are rammed down to grade. This is the outline of my plan, and if all the conditions are complied with I can affirm that no possible city pavement will prove so cheap in the long run, or so perfect or satisfactory in every respect.

FRENCH ACADEMY OF SCIENCES.

JULY.

On the Observation of the Infra-Red Portion of the Solar Spectrum through the Effects of Phosphorescence. By M. E. Becquerel.—The author has previously shown how the rays of the infra-red part of the spectrum which have no action on the retina may act on phosphorescent matters so as to destroy the exhalation produced on them by the blue or violet rays, and thus allow of the study of that region of the spectrum otherwise than by the calorific effects produced there. It suffices to attach a very phosphorescent substance, such as an alkalino-tenous sulphide, on a surface of glass or pasteboard, in order to show the extinction which the infra-red portion of the spectrum may produce on acting for several seconds. When a spectrum properly dispersed is employed, it is observed that this extinction causes unequally active areas to manifest themselves—that is to say, spaces corresponding to the bands or black lines of the solar spectrum. But this observation is difficult, even by elevating the temperature of the surface after the action of the spectrum, and only vague indications have been noted of the positions of the strongest bands. However, with the majority of impressionable substances constant effects with the same prismatic image are obtained if the time of exposure to the light be sufficient.

The author has rendered visible, in continuous manner, a part of the infra-red region which has hitherto escaped all immediate ocular observation, by the following means. In the shutter of a dark chamber two vertical slits are made, through which two parallel beams of sunlight are directed. One beam is caused by means of a vertical prism and a lens, the spectrum to be studied. The prism used contains bisulphide of carbon, and has an angle of 60°. This first spectrum falls on the surface covered with phosphorescent material. The second beam is received on a similarly-disposed prism of white flint glass placed near the first. The position of this prism may be varied so as to superpose the ultra-violet part of the spectrum which it gives on the infra-red part of the first spectrum and so as to move the different very refrangible parts of this second prismatic image also on said infra-red portion. No lens is interposed to the path of the second luminous beam, and its opening in the shutter is made quite large, so as to avoid the production of lines or bands of the ultra violet, which might disturb the observation. Only the first spectrum should give dark lines and bands. A glass colored blue by cobalt may be placed before the orifice of the second beam, so as to eliminate the red, yellow, and green, or more luminous parts of the second spectrum, and thus further facilitate the experiment. If these two spectra with extreme regions superposed be projected on a suitably-prepared phosphorescent surface, the following effect is observed. In the infra-red part of the spectrum with bands the impressionable substance excited by the ultra violet of the second spectrum has its phosphorescence destroyed, but unequally and over a certain extent corresponding to the infra-red portion. Hence unequally illuminated parts appear. The phosphorescent material which gives the most favorable results is hexagonal phosphorescent blende

On Paradol, a new Polymeric Modification of Aldol. By M. Wurtz.—When pure aldol is left to itself it deposits, sometimes after a few days, sometimes at the end of several weeks, colorless crystals which finally fill the entire mass. These are separated from the aldol, remaining liquid, by treating the whole with ether, which dissolves the latter with great facility. A crystalline mass of brilliant whiteness remains, which is repeatedly washed with ether. This body is a polymeric modification of aldol to which the author gives the name of paradol; for it is to aldol what paraldehyde is to aldehyde. On analysis it gives the same figures as aldol. Its point of fusion is 122° Fah., dissolves easily in water, very abundantly in alcohol, and has energetic reducing properties.

On the Production of Electric Current Discharges. By M. A. Boillot.—The author proposes a new apparatus which consists of two tubes of small diameter filled with powdered and calcined graphite, fixed parallel and at a short distance apart. Both enter the entire length of a test-tube seven inches long, and each is terminated by a platinum wire connected with the carbon. One wires traverses the test-tube at its upper portion; the other is curved downward. Two other tubes enter the test-tube, one sloping at the summit, the other entering the orifice for about an inch. The first is intended to conduct the gases in the other for their escape. The discharge is produced in the space comprised between the two carbon conductors.

Experiments on the Radiometer. By M. Gaiffe.—In order to show that the actinic and calorific rays act on the radiometer, the author made an instrument of the usual form, with the vanes painted blue on one side and red on the other. When the radiometer was exposed to solar light, he found that the blue faces had a predominant action, and that the vanes turned from left to right; but when the instrument was exposed to an ordinary gas flame, or to the non-luminous and very hot flame of a Bunsen burner, the red faces became active and rotated the radiometer in the opposite direction.

M. Alverguiat has produced a radiometer with vanes of mica and metal unblackened, which, while sensitive to luminous radiations, is much more so to the obscure heat rays, the mere presence of the hand near it being sufficient to throw it in rapid rotation.

SCIENCE NOTES FROM "THE ACADEMY."

On Vaso-motor Nerves.—Kendall and Luchsinger have repeated many of the experiments described by Goltz (*Academy*, August 14th, 1875), and have arrived, in the main, at similar results (*Pflüger's Archiv*, xiii. 4 and 5). They fully accept his view as to the maintenance of arterial tonus by peripheral organs of a ganglionic nature situated upon, or in close proximity to, the walls of the vessels. These peripheral ganglia they believe to be connected with the cerebro-spinal axis by two sets of nerves, one of which conveys vaso-constrictor, the other vaso-dilator impulses. To illustrate the *modus operandi* of these antagonistic fibres, they refer to Bidder's view of the innervation of the submaxillary gland. According to him, the tonus of the blood-vessels supplying the secreting tissue of this gland is maintained by the automatic influence of a local centre, the submaxillary ganglion, whose functional activity is increased by irritation of the fibres supplied to it by the cervical sympathetic, diminished or inhibited by stimulation of the vaso-motor fibres contained in the chorda tympani branch of the facial nerve. Although their own investigations were limited to the sciatic nerve of the dog and the cervical sympathetic of the rabbit, Kendall and Luchsinger extend the above generalization not merely to all the cutaneous arterioles throughout the body, but to those supplying the tissue of the voluntary muscles as well. In fact, they are disposed to push the analogy which undoubtedly subsists between the innervation of the heart and that of the peripheral arteries as far as possible. Just as the normal contractions of the heart are kept up and regulated by its intrinsic ganglia, so the normal tonus of the vessels is maintained by perivascular organs of a similar kind; just as the activity of the intracardiac centres may be increased by impulses propagated along the accelerator nerves from the cerebro-spinal axis, diminished by such as travel along the vagi, so the activity of the perivascular ganglia may be exalted through the vaso-constrictor, depressed through the vaso-dilator fibres, which connect them with the brain and cord.

Fuchsine Poison.—It has recently been discovered that the aniline dye known as fuchsine, or magenta, is largely employed by dishonest wine-growers in France for improving the color of claret, and masking its dilution with water. Unpleasant symptoms have been observed to follow the use of this medicated beverage; and MM. Feltz and Ritter have accordingly made some experiments in order to ascertain how far the added coloring-matter ought to be blamed for them (*Comptes Rendus*, 26 Juin, 1876). They found that half a gramme of fuchsine in solution, taken on an empty stomach, caused deep redness of the ears, intense itching of the mouth, and slight swelling of the gums. The wine was stained of a deep red color. When the dose was repeated day after day for a fortnight, diarrhœa and albuminuria were developed in addition to the above symptoms. When fuchsine was injected into the stomach or the veins of a dog, it produced effects similar to those observed in the human subject; when the dose was sufficiently large or frequently repeated, albumen invariably made its appearance in the urine; and this symptom was found to be due to a peculiar degeneration of the cortical substance of the kidneys.

Variations of Intracranial Pressure.—By placing the interior of the skull in communication with one of Marey's tympana and writing levers, M. Salathé has succeeded in obtaining a graphic record of the periodical oscillations of intracranial pressure (*Comptes Rendus*, 19 Juin, 1876). These oscillations, synchronous with the respiratory movements, are slight during quiet breathing, and very considerable when there is muscular agitation. Their usual order is inverted when artificial is substituted for natural respiration, the pressure rising during inspiration and sinking during expiration. Besides the respiratory waves, a secondary series of oscillations, synchronous with the heart's contractions, are likewise recorded by the liver. Changes in the position of the body were found to exert a very marked influence on the intracranial pressure. Similar results were obtained by applying a modified form of cardiograph to the forehead of a man who had been deprived, years before, of a portion of his frontal bone by an accident, and whose brain was, therefore, protected only by the soft parts. The tracing showed the respiratory and cardiac waves very distinctly, the latter being markedly dicrotic.

Roscoelite, a Vanadium Mica.—A well-marked species of mica, occurring in a gold mine at Granite Creek, El Dorado County, on the western slope of the Sierra Nevada, and containing a considerable percentage of vanadium in varying degrees of oxidation, is described by Mr. Blake and Dr. Genth (*Amer. Jour. Sc.* [3] xii. 31). The crystals have a dark clove-brown to greenish-brown color, and frequently form stellate or fan-shaped groups. The vanadium appears to be present as $2V_2O_3$, $V_2O_5 = V_4O_{11}$, and in this form constitutes from 20 to 22 per cent of the mineral. Psittacinite, which takes its name from the siskin-green, or rather parrot-green, color of the films in which it occurs, is also described by Genth. It is a hydrated vanadate of lead and copper, having the formula: $3\ (3\ PbO, V_2O_5) + 3\ CuO, V_2O_5 + 6\ (CuO, H_2O) + 12\ H_2O$. It is found, associated with gold and small quantities of cerussite, chalcopyrite, and limonite, on quartz in several of the mines of the Silver Star District, Montana.

Aspartic Acid.—W. von Knieriem has noticed (*Med. Centr. Blatt*), that if a large quantity of gluten be exposed to the digestive action of the pancreatic juice, and, the peptones, leucine, and tyrosine having been removed, if the liquid then be boiled with copper hydrate, that a considerable quantity passes into solution, in which solution the presence of aspartic and glutaminic acid can be detected; and he has confirmed this result by an analysis of these acids. The author has shown that aspartic acid, when introduced into the system, is converted into urea, and he regards aspartic acid as the normal intermediate product in the formation of urea.

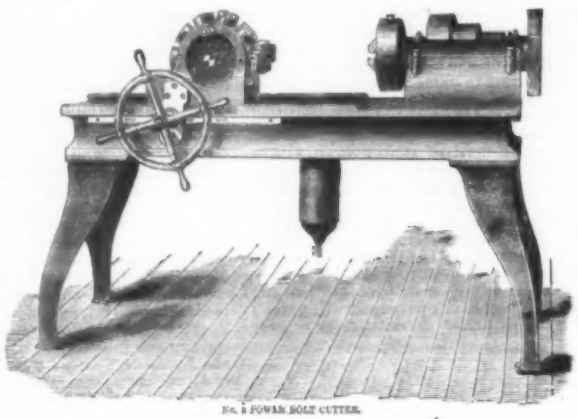
MACHINE TOOLS AT THE EXHIBITION.

OUR engravings illustrate some of the tools made by the Pratt & Whitney Company. Their 16-in. planer has a 5-ft. bed, and planes 16 in. in height and width and 3 ft. 2 in. in length, the table being 3 ft. 6 in. long. The horizontal feed is automatic. The planer has a patent shipping movement and a movable dog, allowing the work when desired to be run either way from under the cutting tool without changing the stops. The planer is run with two 1-in. belts. Weight, with countershaft, 1650 lbs.; speed of countershaft, 270 revolutions per minute. The belts are run at a speed of 50 ft. or 60 ft. per minute to 1 ft. of travel of the table, this high speed enabling the extremely small belts to be used. This tool has a removal hip to allow the table to travel to the full length of the stroke when the work has to be removed or adjusted, without involving the alteration of the stops which regulate the stroke; this is a very simple and neat arrangement. The reversing gear is actuated by a spiral cam. These lathes are fitted with Newell's patent vise, which is also supplied with the pillar shapers. The vise turns on a circular graduated base, so the work may be adjusted at any horizontal angle. One of the jaws is V shaped, for holding circular pieces, and swivels to present either that or the straight face to the work. The actuating screw is protected from chips and dirt. The jaws are faced with hardened steel, and are uncommonly stiff, insuring great accuracy of work.

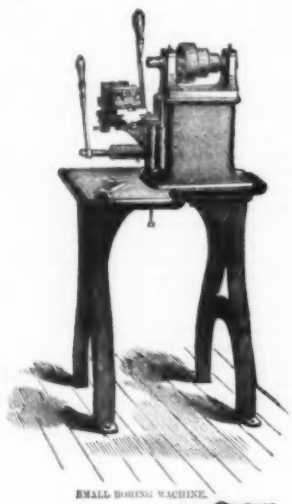
The cutting off lathe is adapted for cutting off round bars or pipe up to 2¼ in. diameter. The iron or pipe passes through a collet at the rear end of the spindle, and is held in front by a universal chuck. The steadying collets may be changed instantly to fit any size of bar to be cut. The cone carries a 4-in. belt. The countershaft is furnished with two sizes of tight and loose pulleys, making, with the cone of the spindle, a large range of speeds. The feed is either automatic or by hand, and it has three speeds. Slate's patent cutting-off tool, with two widths of cutter, is furnished with this machine. The stock of this tool receives the cutter in a channel on its side, and the cutter is held in place by flanges on the stock and two hook headed bolts, allowing the cutter to be advanced as it is ground for sharpening. The machine is 3 ft. 2 in. long, and weighs 600 lbs.

The company have a press at work at their stand producing medals commemorative of the Exhibition for the Centennial Commission. These medals are of very artistic design, and the impressions are clear and sharp. This press is intended for heavy punching, for pressing forgings, and for cold-drawing pieces which are difficult or costly to finish by milling or filing. It is capable of a resistance of 400,000 lbs. The driving-shaft carries a heavy wheel 36 in. diameter, driven by a belt 4½ in. wide. On this shaft is a pinion engaging with a large gear-wheel on an intermediate shaft. A pinion on this shaft gears with another wheel on a shaft that carries the eccentrics which produce the stroke. The gearing is enclosed in a hollow base. The opening in the bed for the reception of dies is 9 in. square. The machines are built with a stroke of from 1 in. to 6 in., as may be ordered.

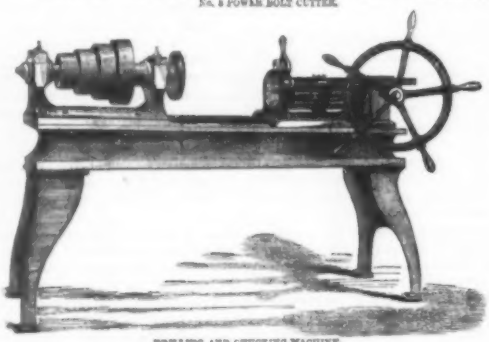
The No. 3 power bolt-cutter is an excellent specimen of this class of tools. The driving-spindle carries a cone of three grades for a belt 3 in. wide, and a pinion engaging with a gear on the hollow spindle, which has at the front end a chuck, for holding the bolt to be cut, or a tap, for threading nuts. The cylinder that holds the dies is mounted on a sliding carriage that is advanced to the work by a hand-wheel, pinion, and rack. The face of the cylinder receives nine collets with threading cutters, and one collet for plates with recesses for holding nuts, either square or hexagonal. The collets and the nut vises are removable at will. Collets, with box tools and hollow mills for turning the body of a bolt, squaring under the head, or pointing the end, may take the places of the threading dies, and the bolt be pointed, turned, squared under the head, and threaded, without its removal from the chuck. The hollow spindle permits work on bolts of any length, and by removing the collet from the place on the cylinder opposite that holding the operating die, a bolt may be threaded to any required distance. The chips and oil are received in the bed, the oil draining free from chips through a strainer into a receiver, from which it may be drawn to be used again. The machine cuts from ¾ in. to 1 in. diameter, seven sizes, as follows, the first figures giving the diameter, and the second number of thread: ¾, 16; ⅞, 14; 1, 13; 1⅛, 11; 1¼, 10; 1⅜, 9; 1 in., 8. These taps and dies cut ¼ large up to and including ¾, and ½ large for sizes above ¾, for use on the rough iron. The main points claimed by the Pratt & Whitney Company are that all the gearing is cut by automatic machinery, the cutters being carried through the proper epicycloidal curves by movements generated in the machines, no setting out by hand being required; all the jaws of the dies are interchangeable and numbered; all screws are made either to the Whitworth or the United States standard.—*The Engineer.*



No. 3 POWER BOLT CUTTER.



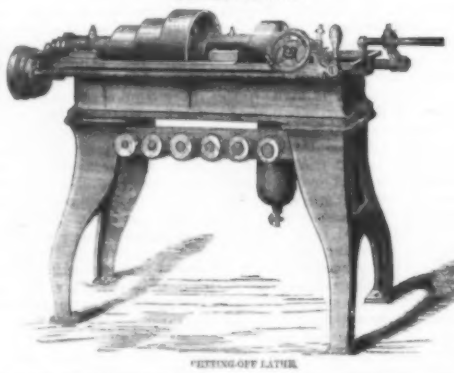
SMALL BORING MACHINE.



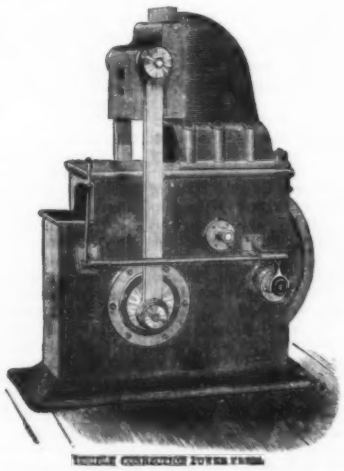
DRILLING AND CHUCKING MACHINE.

SIXTEEN-INCH PLANER.

NEWELL'S PATENT VISE.



CUTTING-OFF LATHE.



THREE CONNECTION POWER PRESS.

THE INTERNATIONAL EXHIBITION OF 1876.—MACHINE TOOLS, BY THE PRATT & WHITNEY CO.

BORAX LAKE AND SULPHUR AND QUICKSILVER DEPOSITS OF CALIFORNIA.

AT the regular Thursday evening meeting, at the rooms of the Centennial Committee, of the American Institute of Mining Engineers, on August 3d, Mr. W. S. Keyes, of Nevada, who is one of the Judges in the department of mining and metallurgy at the Exhibition, gave quite an interesting account of the Borax Lake and mineral deposits near Clear Lake, in California, which he had recently visited.

Clear Lake lies about 65 miles north-west of Susian Bay, the latter being one of the branches of San Francisco Bay. The lake, which is about 25 miles long, has a north-west and south-east direction, corresponding with the trend of the adjacent mountain ranges. Its outline is quite irregular, being long and narrow at its lower end, while near the middle an arm about four miles long projects toward the east. The upper end of the lake widens out and forms an irregular area of about 30 square miles. The country surrounding this end of the lake is formed of high hills which are composed of rocks supposed to belong to the Cretaceous Period. On the south-west and south-east side of the lake the rocks are of volcanic origin, being in most part composed of compact lava with small amounts of pumice and disintegrated scorias. Thermal springs are found in these rocks which give evidence of the more active influence which once were exercised there. The great geysers which lie about 15 miles to the south-west are probably in the same belt of volcanic rocks. In 1856 Dr. J. A. Veatch discovered that the water of a small lake about 4000 feet long and 1800 feet wide, which lies in the neck of land included between the southern end and the eastern arm of Clear Lake, contained a considerable amount of borax. The amount of solid matter contained in a gallon of water was found, by analysis, to be 2401 grains, of which 281 grains were dry borax. Investigations, which were soon made by means of cofferdams sunk in the bed of the lake, disclosed the fact that there was a layer of blue mud about 18 inches thick containing crystals of borax, which bed covered the lake bottom. The deposition of the crystals was irregular, some portions of the mud deposit not containing any. In 1864 a company was formed to extract the borax from this mud, and so successful were they in their operations that in a short time they stopped all importations of the article from abroad and brought its price down from about 25 to 10 cents a pound. An operation similar to the killing of the goose which laid the golden eggs was undertaken by the company, which put a stop to their operations. With the hope of striking springs which supplied the lake with concentrated borax-water, they put down a bore-hole which, unfortunately for them, struck a strong vein of pure water and soon increased the body of the lake to such an extent as to prevent them from working the borax any longer.

SULPHUR AND QUICKSILVER DEPOSITS.

Mr. Keyes then spoke of a mineral deposit which, with regard to its composition and method of occurrence, was not paralleled, so far as he knew, anywhere else in the world. This is a deposit of what was thought to be native sulphur, and which was first discovered at the extremity of the bay on the east side of Clear Lake. This deposit, which has since been traced towards the east for over 3000 feet, lies along on both sides of a fissure through which, in several places, thermal springs containing bicarbonate of ammonia, free carbonic acid, chloride of sodium, bicarbonate of soda, and free silicic acid have been discovered.

Explorations which have been made to a width of 1000 feet across this fissure have shown that there is a top deposit from two to three feet thick, which is composed of disintegrated lava mixed with a small amount of sulphur and cinnabar, yielding from ½ to 1½ per cent of mercury. Under this decomposed lava there is a bed of impure sulphur, from six to eight feet thick. The amount of sulphur in this layer varies from 30 to 80 per cent, the sulphur sometimes being in nearly pure lumps of considerable size. The gangue material mixed with the sulphur is lava similar to that found in the bed above. Lying beneath this sulphur deposit is a bed of lava, which has been found to contain from 1½ to 2½ per cent mercury in the form of cinnabar, and also a little sulphur. This bed has been investigated to a depth of 75 feet without discovering its bottom, and is found to cover nearly the whole area along and across the fissure of 3000 by 1000 feet. The first effort which was made to work any of these deposits consisted in an attempt to refine the sulphur found in the sulphur bank, by distilling it in the ordinary manner in retorts. Repeated efforts to do this were unsuccessful, owing to the necks of the retorts becoming stopped up by something, the nature of which was not then recognized. This afterwards proved to be a small amount of cinnabar which was mixed with the sulphur. The attempt to work the bed was soon given up, and no operations were carried on again at the deposit until 1874, when the Sulphur Bank Mining Company commenced working both for the sulphur and the mercury.

NEW PROCESS OF SULPHUR EXTRACTION

The process employed for extracting the sulphur is a novel and exceedingly simple one. The apparatus used consists of an inverted T retort made of cast-iron, and having an oval section. Doors which can be luted are made at the top and front ends of the retort. Inside of it a perforated plate of sheet lead is placed on the bottom, underneath which are openings through which steam can be admitted. The bottom is set so as to slope toward one end, and at the lowest point there is a discharge-pipe for drawing off the semi-refined sulphur. The method of operating the retort is as follows: Lumps of the impure sulphur are piled up on the lead bottom before described, this being done from the end doors. After the lower portion is filled in in this way the vertical portion or shaft has the finer parts of the impure sulphur thrown into it. The doors are then luted on, and steam, at a pressure of 31 pounds to the square inch, is admitted through the holes in the bottom of the retort. This soon permeates the mass of the sulphur material, and at the pressure of 31 pounds its temperature is just that required to render the sulphur liquid. The sulphur when melted runs down through the perforated plate, which prevents the passage of the gangue material, and collects in the bottom of the retort. When sufficient has collected it is drawn off through the discharge-pipe. The valve used to close this pipe is jacketed, so that the sulphur is kept in a melted state by the steam, such as is used in the retort. The slight amount of fine dirt which unavoidably runs down with the sulphur through the perforations in the lead plate alone prevents it from coming out in a perfectly pure condition. One great advantage in extracting the sulphur in this way is due to the very low heat employed, which is not sufficient, as in the ordinary re-

fining process, to cause the sulphur to attack the iron. The residues which remain are afterward treated for the cinnabar which they contain. The sulphur is shipped to San Francisco, the freight costing at present $10 per ton.

For extracting the mercury from the cinnabar, three apparatuses are used. The richer specimens of ore and residues are put in retorts with lime, as is commonly practised at New-Almaden. The less pure ore, which is found in lumps, is worked in continuous furnaces, in which it is filled up so as to admit the flame from the combustion chambers between the interstices. The fine ore is worked in a modified Gerstenhöfer furnace. In these continuous furnaces the mercury is condensed in iron chambers, from 8 to 10 of which are used for each furnace. It is found by experience that the larger each of these chambers is made, the less "soot" mercury will be formed.

The passage of the mercurial fumes through these chambers is assured by means of suction currents produced by Root's blowers and the draught afforded by a high chimney to which all the condensers are attached. With regard to the probable amount of mercury in this deposit, Mr. Keyes said, that according to the estimates of J. D. Hague and Messrs. Ashburne & Price, the portion already exploited—namely, 3000 x 1000 feet—contained from one and one half to two per cent of the metal. This was for a depth of 75 feet, there being no indications that the deposit did not extend even deeper than this. Mr. Vincent, an English engineer, estimates that the same one contains two and one-half per cent of mercury, which would make it have a value of $40,000,000, at 50 cents a pound. The easy method of mining which is employed, being nothing more than quarrying in benches combined with the simple furnaces used for extraction, have enabled the Sulphur Bank Company to produce the mercury at an exceedingly low price. Mr. Keyes said that it could be made at as low a cost as 18 cents per pound. At the time of Mr. Keyes's visit, a few months ago, there were from 20,000 to 30,000 tons of the lower cinnabar deposits ready to be roasted. Besides this deposit another similar in character has been discovered on the other side of the lake, which is owned by the same company.

LOCOMOTIVES AT THE EXHIBITION.

IN our SUPPLEMENT No. 35 we gave reduced diagrams and table of leading particulars of the various locomotive exhibits at the Centennial. We present herewith a sectional elevation of one of the exhibits of the Baldwin Locomotive Works, being a locomotive made for the Central Railroad of New Jersey, for which we are indebted to *Engineering*.

DIMENSIONS.

	Ft.	In.
CYLINDERS:		
Diameter	1	5
Stroke of Piston	1	10
Length of steam ports	1	3
Width " "	0	1½
" of exhaust ports	0	2½
Travel of valve	0	5½
Outside lap of valves	0	0¼
Inside " "	0	0 5/32
Exhaust nozzle—single.		
WHEELS:		
Diameter of driving wheels	5	2
" truck wheels	2	4
Distance between centres of front and rear driving wheels	8	6
Total wheel base of locomotive	22	5
" " " and tender	44	2½
Diameter of driving axle journals	0	7
Length " "	0	8
Diameter of main crank-pin bearing	0	4½
Length " " "	0	4½
BOILER:		
Outside diameter of smallest ring of boiler	4	0
Thickness of boiler plate (steel)	0	0¼
Number of tubes—163.		
Length "	11	3
Outside diameter of tubes	0	2
Length of fire-box inside	8	6
Width " "	2	9½
Depth " " (sloping)—39-53.		
Thickness of fire-box plates (steel), side sheets	0	0½
" back sheet	0	0 5/16
" crown sheet	0	0¼
" flue sheet	0	0½
Square feet of grate surface—24.		
" " heating surface in fire-box—112.		
Square feet of heating surface in tubes—953.		
Total square feet of heating surface—1065.		
TENDER:		
Number of wheels—8.		
Diameter "	2	6
" tender-axle journals	0	3½
Length " "	0	7
Capacity of tank	2200 gallons	
WEIGHT:		
Weight of engine in working order	75,000 lbs.	
" " on driving wheels	51,500 "	
" of tender, empty	20,500 "	

SAFETY IN INDUSTRIAL OCCUPATIONS.

AN offer of a medal in connection with this subject has been made to the Society of Arts by Mr. Benjamin Shaw, and has been accepted by the Council.

The medal will be of the value of £20, and will be awarded every fifth year. Mr. Shaw has directed a sufficient amount of Consols for the purpose to be transferred into the name of the Society.

The terms of the offer are as follows: For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means.

The first award will be made in May, 1877.

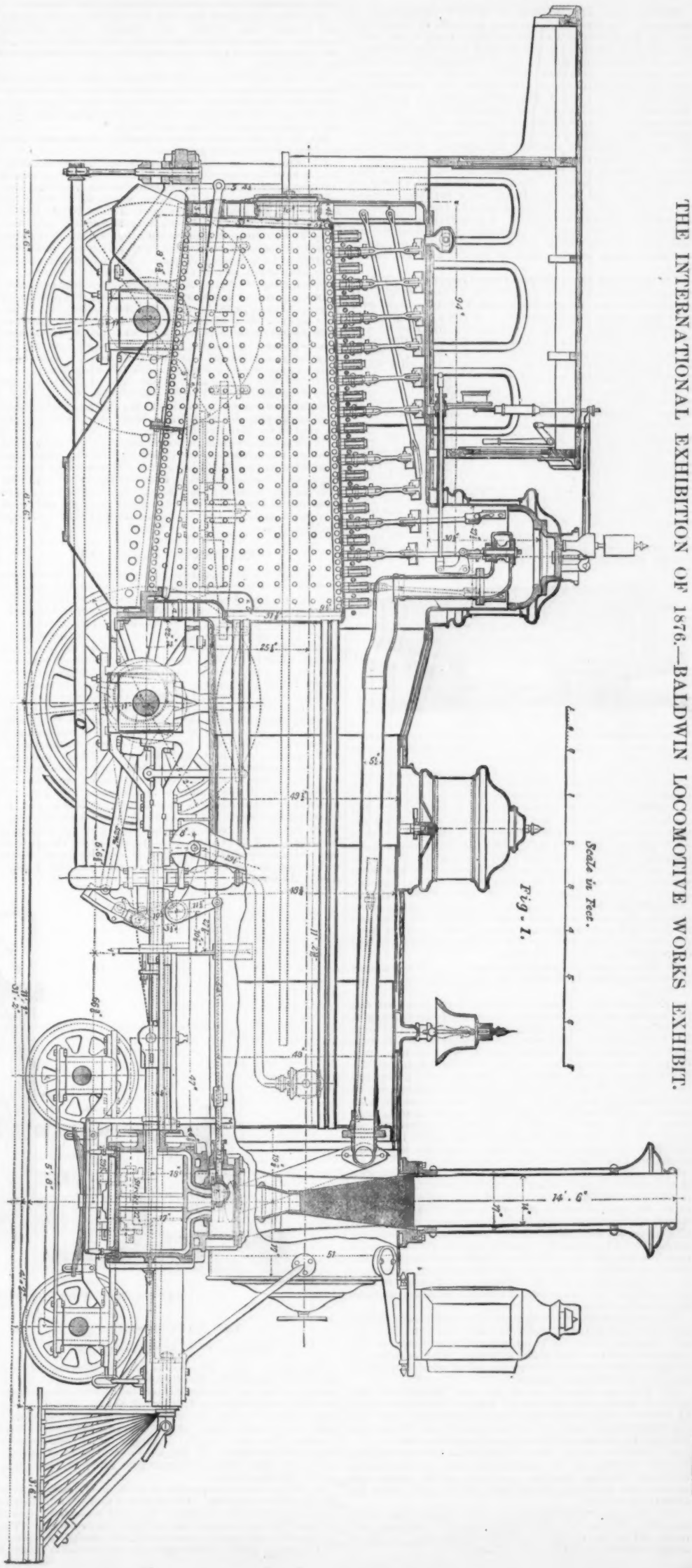


Fig. 1.

THE INTERNATIONAL EXHIBITION OF 1876.—BALDWIN LOCOMOTIVE WORKS EXHIBIT.

STEEL RAILWAY CARS.

THE problem of the hour, in railway management, is economy. The line which can carry its traffic at the smallest cost, not for a week or a month, but right along for an indefinite series of years, is the one which is to be most successful. Many elements enter into the cost of transportation, but none is of more importance than durability of road and equipment. Steel rails have commenced a revolution, the wonderful results of which the world has hardly begun to appreciate. The increased durability of the permanent way, which their use entails, has already reduced the cost of transportation, and will have a lasting and increasing effect in that direction. No one now thinks of doubting the economy of steel rails, even though they should cost twice or thrice the price of iron. It is not unlikely that the permanent way of railways may be still further improved. There are doubtless already in use systems of rail fastening which are a vast improvement on the old styles. Iron or steel sleepers or ties may possibly supersede wood with advantage. A perfect and permanent way must and will combine durability with evenness and uniformity, in order that it may have the greatest endurance and have as little wearing effect as possible upon the rolling stock.

But there is another problem of equal importance with that of the roadbed and track: the problem of dead weight. It is self-evident that the greatest economy will be found in a train that has the largest proportion of paying weight. All superfluous weight not only consumes fuel, but also adds to the wear and tear of the rolling stock itself and the track. In order to reduce the dead weight to the utmost, it would seem necessary to construct the cars of that material which combines the greatest strength with the least weight. It is a little strange, to say the least, that while steel has been substituted for iron in rails, and iron and steel for wood in bridges, and corrugated iron for wood in buildings (all with such admirable results), cars should be constructed from the same materials and on much the same principles that they were a score of years ago. The stumbling-block has doubtless been the question of weight. It is natural to suppose that an iron or steel car must necessarily be much heavier than one of wood. So it was once supposed that an iron ship would sink. Both ideas are equally fallacious. It has been fully demonstrated that by the use of proper material, arranged in the scientific way for securing the largest proportion of strength to weight, cars can be built which are at the same time lighter, stronger, and hence more durable, and of greater carrying capacity, than any that are now built of wood.

STEEL RAILWAY CAR.

The materials which have wrought this result are steel rods and charcoal iron boiler tubes. The La Mothe Manufacturing Co. is building cars from these materials, which they adopted for the following reasons: The steel is the strongest material, is elastic, durable, can be bent cold in continuous rods to the required shape of the cars (thus retaining its strength and saving time), and is, of course, fire and splinter proof. For the bottom of sills the best charcoal iron boiler tubes are used, because a tube is the strongest and stiffest form of a given quantity of metal; it is lighter than any other material with the same tensile strength; the principal weight of the car can be brought nearer the track than with any other material; and, lastly, it is most durable. This company claims it has demonstrated that by using these materials combined and interlocked by their plan, cars can be built from 25 to 40 per cent lighter than those in ordinary use; that as a result of this greater lightness, strength and carrying capacity, fewer trains will be required, and thus management will be simplified and accidents lessened.

The idea of metallic cars is not a new one. We condense the following from *Le Moniteur Industrial Belge* on their use in Europe:

"Early cars were of wood, without buffers; these last, and traction springs, were then introduced; later, the bending of the sills was partly remedied by reinforcement with plate iron 4 to 6 inches thick. This was next replaced by rolled iron; next the wooden buffer beams were replaced by iron; now the use of iron cross beams is general. Wooden cars of 22,000 lbs. capacity cost $22 gold for annual maintenance, and last 16 years. On various Belgian lines, the average cost of maintenance of iron cars for carrying coal is but 15 cents yearly. The life of an iron car can not yet be stated, there being but 15 years' experience; although one covered car entirely of iron was made 30 years ago and is still in perfect condition. No more of this class were constructed on account of the great heat in cars of this construction.

"In Germany, iron cars for freight are widely used, with good opinions; repairs being less, safety greater, and derailments less frequent, on account of the parallelism of the axles. In upper Silesia there were, in 1867, 1200 iron cars in service; in Saarbruck roads, 1000. The former weigh about 12,100 lbs.; the latter a little less. The dead weight of these cars of 22,000 lbs. capacity generally exceeds that of wooden cars. In Belgium they weigh but 10,000 to 10,500 lbs. The German builders use four sills, two being braces, in the form of a St. Andrew's cross. In Belgium iron frames are used for passenger cars, and in case of collision prove stronger and safer than those of wood."

The principal objections against all metallic cars heretofore built have been that they were too heavy, too hot, too cold, too noisy, could not be ornamented or repaired, are too expensive, and that they shake to pieces. The La Mothe Co. claim that their cars have overcome all of these objections, and give the following reasons:

1st. They are from 20 to 40 per cent lighter than the ordinary wooden cars, because the body of the cars are built of soft steel rods, without weak points anywhere—there being neither joints, mortises, tenons, rivets, etc., but, on the contrary, the framework throughout is a perfect unit.

2d. They are not hot, because there is an external and an internal covering of thin sheet metal, with an intervening substance between the two coverings, which makes the metallic cars positively cooler than wooden cars under the same circumstances.

3d. They can be warmed quicker and cheaper than other cars, from the fact that the internal metallic covering will retain and radiate the heat created inside the car, in lieu of being absorbed, as in the case with wood.

4th. They are less noisy, because the non-conducting substance between the two coverings absorbs all vibrations.

5th. When damaged, they can be repaired much quicker and cheaper than wooden cars, because when severely knocked, as in a collision, they merely bend more or less, and can be straightened again as good as new, whilst wooden cars break to pieces.

6th. The first cost of the metallic cars is about the same as first-class wooden cars, but when their superior qualities are taken into consideration, it will be found that the saving to railroads, by the use of steel cars, will be so great that every well-managed road will run none others.

7th. They can be made more beautiful, cleaner and more comfortable than any wooden cars.

8th. From the nature of the material and mode of construction, it must be apparent they never can be shaken to pieces.

Experiments already made have demonstrated that cars can be manufactured on this plan, which, while weighing less than 15,000 lbs., will carry safely from 24,000 to 30,000. By using steel trucks, cars weighing 20,000 lbs. only, will carry 50,000. Any one familiar with the weight and carrying capacity of ordinary cars (which carry only about their own weight) will appreciate this point. The advantage may be illustrated as follows:

"By the report of the State Superintendent it appears that the average cost of transportation upon the Erie for the past 13 years, ending in 1874, was .01.215-1000 cents per ton per mile, and that the road employs 10,775 freight cars. Each of these weighs on an average at least 4000 lbs. (2 tons) more than necessary. Supposing these 10,775 freight cars run on an average only 30 miles per day (they actually run much more on most roads), and we have the following result:

"10,775 cars × 2 tons = 21,550 tons: 21,550 tons × 30 miles = 646,500, at .01.215-1000 = $7854.98 for one day's run: $7854.98 × 300 days = $2,356,494.00, the amount actually spent in carrying that superfluous, dead, non-paying weight one year on the Erie Railroad.

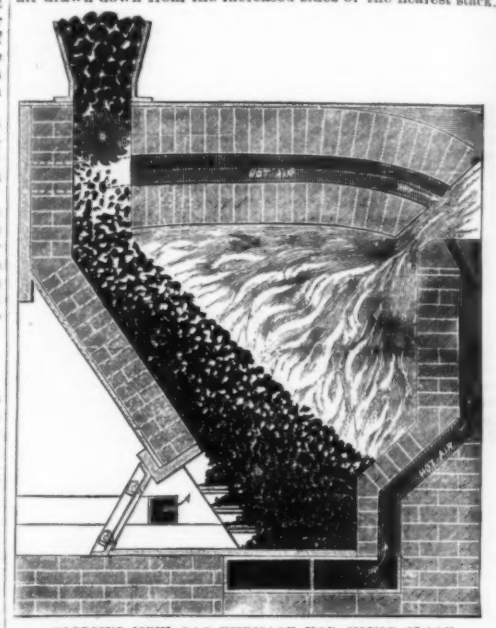
"This estimate relates to *freight cars only*. If we add the earnings which the increased carrying capacity (fully one third) of steel cars would bring to her treasury, the further difference in cost of repairs and the saving which might be made in her passenger cars and traffic, it will be at once apparent that this splendid road properly equipped with steel cars would earn and pay a handsome dividend."—*Chicago Railway Review.*

STEEL-MAKING IMMIGRANTS.

IT is reported, and apparently it is believed by those who should be most interested in knowing whether the report is true or not, that there is to be an exodus of British steel manufacturers to this country. All that is positively known, however, is that one large Sheffield firm has been buying property in the vicinity of Syracuse, with the intention of going largely into the manufacture of steel for the American market. It is said further that there has been some sort of a hitch in the arrangements, and that the enterprise is not yet wholly certain to be undertaken. There is, of course, no sort of objection to the coming of British makers of steel, if they think they can make any money by so doing. We should encourage them to come and bring their capital with them. The field is open to them. If they come, it will be a new triumph for the system of Protection. Moreover, the threatened invasion of the United States by British manufacturers is a good symptom in another aspect. The iron and steel trades are in a condition by no means prosperous at present, either in this country or in England. This fact is as well known to the Sheffield manufacturers as it is to us. If, therefore, they see fit to transfer their business to this country in the present season of depression, it is an indication that they think the day of great prosperity for the trade in England has passed, and that they believe the United States will become the best field for the exercise of their trade.—*Boston Advertiser.*

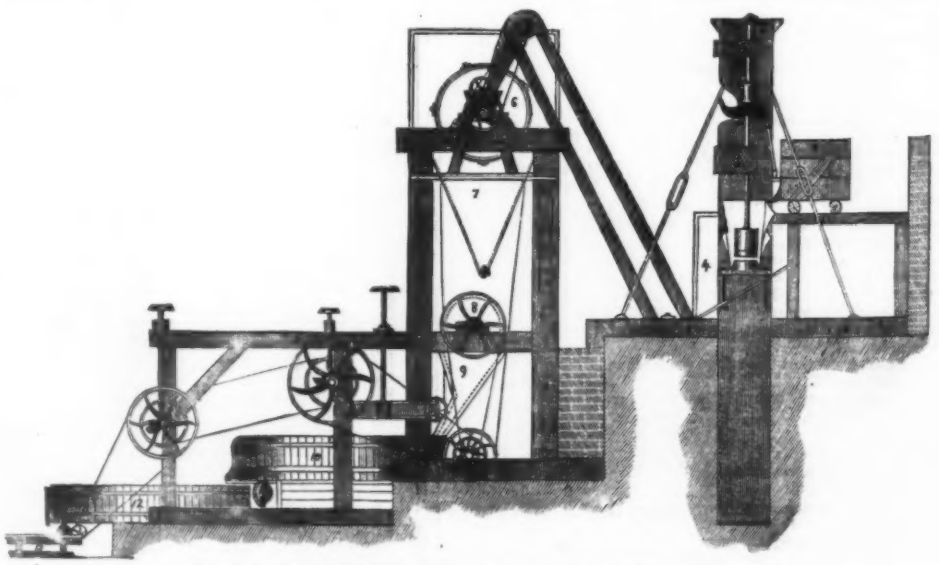
CASSON'S NEW GAS FURNACE.

AT the Round Oak Works, England, Mr. Smith Casson has applied a new gas and hot-blast furnace to a Casson-Dormoy puddling furnace. The coal used is screened slack. This, it will be noted, is supplied into a hopper and drawn down into the grate. Through the back of the grate it is blown by hot air drawn down from the increased sides of the nearest stack.



CASSON'S NEW GAS FURNACE FOR USING SLACK.

Hot air is likewise, it will be seen, taken in at the top and also at the bottom of the furnace, and makes its way to the exit of the gas from the gas furnace before it passes over the bridge of the puddling furnace, and the hot air fires the gas. The fierceness of the flame can be regulated by the quantity of air admitted, and the air is under the control of the puddler. The heat which the gas supplied was of great power and manifest purity, and the apparatus seemed to be working very well. The Casson-Dormoy furnace is a double furnace having circular rotating beds and actuated by mechanical rabbles. In this case the rabble machinery was



PAUL'S DRY PROCESS FOR GOLD AND SILVER ORES.

THE PAUL PROCESS.

By A. B. PAUL, San Francisco, Cal.

THE plan of Paul's dry-process mill, for working gold and silver ores, is shown in the illustration on this page. By referring to the cut the details may be understood. 1 shows the position of calcining furnace; 2, the self-feeder; 3, the stamp battery; 4, dust casing; 5, elevators (these are not used when the ground admits of the battery being set on a level with the pulverizing barrel); 7, hopper for pulverized ore; 8, amalgamating barrel; 9, hopper for conveying ore to the settler; 10, first settler; 11, amalgam safe; 12, hydrostatic settler; 13, concentrator.

The ore is reduced to powder by attrition of quartz, and the amalgamation is speedy. Ore is passed into self-feeders, and that is the last of the handling. The gold contained in it will be found in the amalgam safe, all ready for retorting. The machinery is ingeniously constructed, and works effectively. It is rendered perfectly automatic, so that, from the moment the quartz is put into the feeder until the gold comes from the machine in the shape of amalgam, the stuff is not handled.

Mr. Paul has given many years of study to the scientific manipulation of ores and mechanical construction of this mill, as simple as it looks. The simplicity of the mill and the cheapness with which Mr. Paul says he can work the ore must make it desirable. Only two men are necessary to run a 10-ton mill. A mill of this pattern is now being erected in this city for the purpose of proving to those interested in mining all that Mr. Paul has claimed, and where parties can get all the ore worked that will be necessary to make the practicability of the mill acceptable. It will be open to the close inspection of the most critical. Mr. Paul's experience in these matters covers some 25 years on this coast, and he is not one to claim more than he knows he can accomplish.—*Mining and Scientific Press.*

PROF. C. WYVILLE THOMSON, director of the scientific staff of the Challenger, has received the honor of knighthood from Queen Victoria

DIPHTHERIA.

BEFORE the New York Academy of Medicine, Dr. C. E. Billington read a paper on this disease and its treatment, which was especially valuable, as it was based entirely upon clinical and personal experience; his observations having been made with great care, and extending over a large number of cases. The records of the Bureau of Vital Statistics showed, said he, that in 1873 there were over four hundred deaths from diphtheria in this city; in 1874 over one thousand, and in 1875 no less than two thousand three hundred and twenty-nine. This terrible epidemic he thought could not be checked by any therapeutic methods, but could only be stamped out by the most revolutionary and active sanitary reform. Dr. Billington has enjoyed unusual facilities for the study of the disease, as he is one of the District Physicians of the Demilt Dispensary, and has seen altogether about three hundred cases, of which he has careful records of about one half.

As a result of his observation and study, he has become fully convinced that diphtheria is a local disease, at least primarily; and, though this is the opinion of a minority of the authorities on the subject, he is glad to have his views corroborated by such observers as Drs. Jacobi and J. Lewis Smith. This conclusion is based upon the following points:

First. The local affection commences first.

Second. The gravity of the general symptoms is in proportion to the severity of the local manifestations.

Third. The results of treatment seem to substantiate this view.

In the study of the nature of the disease, he said, three elements were to be considered:

(1) The *contagium*, which he did not propose to discuss on this occasion.

(2) The inflammation, denuding the fauces of epithelium, and resulting in membranous exudation; and

(3) The effects reflected from the inflammation upon the system in general are, to a greater or less extent, septicæmic in character.

Dr. Billington's treatment consists mainly in local disinfection, together with the most careful and unremitting watching and attention. The agents which he regards as most useful are the following, in the order in which they stand in his estimation: Tincture of the chloride of iron, lime-water and glycerine; and after them, salicylic and carbolic acids, sulphite of sodium, chlorate of potassium, etc. One formula which he uses in almost every case is as follows:

R—Tinct. ferri chlor., *f* dr. iss.
Glycerinæ.
Aquæ, aa *f* oz. j.—M.
S.—Teaspoonful every hour or half hour.

Besides being very effective, it has the merit of being pleasant to the taste, which is a great desideratum for children, especially when the dose has to be so frequently repeated. If the child is under two years, one drachm of the tincture of the chloride of iron is enough, and if vomiting follows the administration of the medicine, it should not be given so often.

In connection with the above, Dr. Billington formerly employed the following:

R—Potass. chlor., dr. iss.
Glycerinæ, *f* oz. ss.
Liq. calcis, *f* oz. iiss.—M.

A teaspoonful of this was alternated with a dose of the former; so that the patient would receive one or the other every half hour. As a substitute for the chlorate of potassium mixture, he now generally uses the following:

R—Acid salicylic, *gr.* x—xv.
Sodii sulphit., *gr.* xxx—xlv.
Glycerinæ, *f* oz. ss.
Aquæ, *f* oz. iiss.—M.

Here the salicylic acid is rendered soluble by the addition of three times its weight of sulphite of sodium (borax also has the same effect), so that in this prescription we have the advantages of both these reputed antiseptics, which are indicated theoretically, and really seem to be of considerable practical benefit. It is of great importance that in every case in which it is practicable some sort of spray should be used upon the throat; and the most convenient instrument with which to accomplish this is the ordinary little perfumery spray-apparatus now in such general use. In order to annoy the child as little as possible, it is best to employ the spray immediately after a dose of the medicine is administered. The combination generally used by Dr. Billington is the following:

R—Acid, carbolic, m.x.
Liq. calcis, *f* oz. iv.—M.

He believes that the nasal douche or syringe has saved many lives; and even when the nasal passages, apparently, do not seem affected, it is often useful in reaching portions of the mucous membrane inaccessible to the spray. If, therefore, the breath should remain fetid after the employment of the latter, it ought to be resorted to; and the mixture mentioned above, containing the salicylic acid, is as good as any other for the purpose.

In adults or large children it may occasionally be of service to apply carefully strong tincture of iron (say two parts of the tincture to one of glycerine) to circumscribed patches of membrane; but, as a rule, topical applications of caustics or astringents by the probang or camel's-hair brush do much more harm than good, as they cause exhaustion of the little patients from their struggles to resist, excite an increased flow of blood to the part, and really occasion further thickening and spread of the membrane.

Dr. Billington expressed the opinion (which is hardly substantiated by other observers) that quinine is worse than useless in diphtheria in children; being objectionable, if for no other reason, on account of its bitter taste, which makes every dose dreaded by the patient.

In cases attended with high secondary fever, a full dose of quinine worked better in his hands. He can not subscribe to the prevalent opinion that diphtheria will never bear antiphlogistic treatment.

Dr. Billington then proceeded to give an interesting summary of the cases which he had personally observed, prefacing his statement with an allusion to the well-recognized disadvantages to be encountered in dispensary practice. According to his observations, about sixty-five per cent of all cases of diphtheria occur in persons under five years of age, and it is quite a rare affection among adults (except in the peculiar experience of certain irregular practitioners), even when individuals are constantly and to the fullest extent exposed to the disease. He has also found that about sixty per cent of all the cases will recover without any treatment at all, and that about five per cent will prove fatal whatever plan may be adopted. Out of one hundred and two carefully tabulated dispensary cases treated by him, fourteen died, and eighty-eight recovered; while of seventeen cases in private practice, one died, and sixteen recovered.

The usual duration of the attack, from the commencement of the treatment to the disappearance of the diphtheritic membranes, was only from four to six days. Twenty-four cases in private practice, treated on the same principles by Dr. Wm. Darken, house physican to the Demilt Dispensary, show even a better result; as not a single death occurred directly from the disease, though one of the children died several weeks after the acute attack, from some unexplained cause.

A still later series of fourteen cases treated by Dr. Billington in conjunction with Dr. W. E. Bullard (in order that the patients might receive the fullest possible amount of attention) all recovered, so that we have fifty-five cases altogether, with only one death directly attributed to the disease. In a large number of these the attack was of very great severity.

From his observations, Dr. Billington has been induced to believe that a laryngeal complication can often be prevented or aborted by the use of the spray, and that even after the membranes have been fully formed in this locality it is of very great service. Calomel has also proved useful in many cases. The inhalation of *hot* vapor, he thinks, renders the system more favorable to the absorption of septic materials, and therefore injurious.

He did not express a positive opinion as to the identity of croup and diphtheria, but apparently seemed to hold to the former view.—*Canada Lancet.*

SULPHIDE OF CALCIUM.

By T. CURTIS SMITH, M.D., Middleport, Ohio.

I TAKE pleasure in calling attention to this remedy for action in a field where an agent that will produce the effects claimed for it is much needed—namely, in discussing glandular swellings which threaten suppuration, in furuncular eruptions, carbuncles, and chronic induration of various tissues, the result of inflammatory action. Sidney Ringer, of London, has done much to bring this prominently before the profession as a valuable therapeutic agent. He, however, signally fails to give the rationale of its mode of action upon the physical economy, further than to claim great alterative action for it. This is but another method of covering up our ignorance of the real actions of various drugs now in general use.

I have used this agent more or less for a year past, and am well satisfied that it possesses some valuable properties for difficulties of the classes above named.

In cases where glandular abscesses are threatened in scrofulous children, it has the effect to hasten their removal by either rapidly increasing their tendency to suppuration and rapid healthy granulation, or of removing them quickly by absorption without suppuration. This seems like a contradiction of terms, but we may well remember that other and apparently less potent agents have similar therapeutic value. Very often warm, moist applications are used to assist in alleviating inflammation, and the same kind of applications are also used to hasten suppuration. So we claim no more for this agent than has long been practically claimed in these different actions for a common poultice, but we hold that it is far more efficient.

We not unfrequently meet with glandular swellings in strumous children and adults, not of specific origin. These often become very large. Sometimes, after weeks of suffering and inconvenience from the swellings, they suppurate, and after opening are very slow to heal, and for weeks will discharge an unhealthy-looking pus; and when they have healed, too often leave very ugly cicatrices about the neck. If in such cases the sulphide of calcium is given, and without any other aid, these swellings, however large they may be, will soon disappear, unless suppuration has already begun. In the latter case, instead of a long, tedious course of waiting through days and nights of suffering, and increased general debility, they will rapidly hasten to a termination by the suppurative process. The pus formed under its use seems of a more laudable character than that commonly observed in strumous abscesses, and after being discharged, healthy granulations spring up; soon the swelling has disappeared, and the point of opening has closed, leaving very little trace of the former trouble. If no pus has already formed in these large, threatening, indurated glands, then under the sulphide of calcium they soon become less in size, and in a remarkably short time disappear.

Another use of no mean value for this agent is in the treatment of boils. Several times in the last year have I met with cases where a succession of crops of furuncles would appear. As one crop would commence to decline another would put in an appearance. In all of such cases, where the sulphide of calcium has been resorted to, they have speedily recovered. The boils already formed would quickly suppurate, and discharge profusely, the "core" melting away with astonishing rapidity. The little boils just commencing to form would rapidly disappear without ever becoming painful, and no trace of them could be observed. The points were notably gained in the case of an old lady who was so much annoyed from the boils that she could not sleep day or night, nor move in any direction without pain, often severe. In a few days she was relieved completely. Also in a recent case where a succession of these painful abscesses had occurred, those present rapidly disappeared, and have not yet returned.

In carbuncles I have had a more limited experience. Sidney Ringer is loud in his praise of the remedy in this very painful affection, and especially mentions the rapid solution of the indurated "core," and the formation and discharge of healthy pus, followed by rapid granulation, and not followed by a repetition of the swellings at other points.

In those children that are, from some constitutional vice, subject to a constant repetition of ill-conditioned sores, often greatly annoying them, and, from their very slow tendency to heal, last for weeks and months, the sulphide of calcium will soon effect a rapid recovery and prevent a tendency to their return.

I have recently used this remedy in a few cases of visceral indurations of long standing, with the effect of a rapid removal of the morbid condition and a speedy improvement in the general health. I am now trying its influence over some very intractable diseases, but can not yet speak of its power in these new directions.

I have noticed, in the use of this agent, that there has been a general improvement in the health and vigor, and that especially the nervous system seemed to become more efficient, and through this and its alterative power there would be a general improvement in the secretions; the skin and kidneys would act more freely; the bowels, if costive, would become at once regular; any tendency to acidity of the stomach would be partially or completely removed. I believe its influence in toning the nervous system is an effect fully as important as its alterative power. Time and an extensive use of this agent will decide whether it will maintain the high stand it now seems to claim.

Ringer claims the same effect for the sulphides of potassium and sodium. I have only used the sulphide of calcium. Dr. Ringer recommends doses of one tenth of a grain repeated every two hours. It has been my habit to give to young children a half grain every four to six hours, and to an adult, from a half to two grains in sugar four to six times a day. Its odor is disagreeable, and similar to that given off by the Blue Lick mineral waters of Kentucky, and not unlike sulphuretted hydrogen. The taste, however, is easily concealed by mixing with sugar or making into pill. The solution in water can not well be attained, and if it could, it would be very unpleasant to the patient to take.

I have no reason to believe the agent would have any special power over syphilitic indurations of any kind, but have not extended the use of the agent in this direction to ascertain what power it might exert, except in a single case, where it was used in connection with mercury. The results were good, but whether the agent had any influence or not, I can not say.—*Southern Medical Record.*

CHLORIDE OF SODA IN CANCEROUS ULCERS.

By G. M. RIVERS, M.D.

ABOUT three years ago, I was requested to visit an old lady with an ugly ulcer of the left breast. The whole gland was involved in the disease, hard and uneven to the touch—the ulcer three inches in diameter, quite deep, with raised, ragged and irregular edges; in fact, presenting all the appearance of true cancer. I had previously attended two cases of cancer of the breast, both of which presented the same appearance and proved fatal. I held out no hope of recovery, but advised and instituted, as I believed, a purely palliative treatment. I directed the ulcer to be covered with simple cerate, and, to destroy the odor, to be washed twice a day with a solution of chloride of soda—Laberaque's solution, in proportion of three ounces of the chloride to five of water. In three or four months, with no other treatment whatever, except small doses of morphine to relieve pain, the ulcer had perfectly healed, the swelling and inflammation subsided, and the patient cured. It has now been more than two years, and the disease shows no disposition to return.

The second case upon which I tried this remedy was a young negro woman, about twenty, with half the left nostril and a large portion of the upper lip destroyed. This woman had been to the hospital in Charleston, and the physicians there had pronounced it cancer. Upon this case I used the chloride very freely, injecting into the nares as well as applying it externally. In four months the patient was cured, the last integument restored, leaving less deformity than I thought possible.* In this case, also, I used no other remedy, except to protect it from the air with simple cerate.

The question will naturally occur, Were these cases true cancers? Their recovery alone makes me doubtful. I certainly had no doubts when I first saw them. But may not the chloride of soda be a remedy? It is as good as any thing else. Why not try it? Some of our most useful remedies have been discovered by accident.—*Southern Medical Record.*

A MULTIPLE ANTIDOTE.

DR. JEANNEL of Paris, has endeavored to answer the question, Is it possible to prepare an agent which shall be officinal, that is susceptible of indefinite preservation, capable of neutralizing chemically all poisons in the stomach or in the intestine, or, at least, of transforming them into compounds relatively inoffensive, and then determining their prompt evacuation? He discusses the applicability of the agents suggested by Dorvaul for this purpose, pointing out what appears to him to be the excellences and defects of each, and finally proposes the following:

	Grammes.
Solution of ferric sulphate, s. g. 1.45	100
Water	800
Calcined magnesia	80
Washed animal charcoal	40

Let the solution of ferric sulphate be kept in a bottle by itself, and the magnesia and charcoal mixed with the water in another bottle. When required, pour the ferric solution into the other bottle, and shake violently. The mixture should be given repeatedly in doses of fifty to one hundred grammes.

According to Jeannel's experiment, this antidote, employed in suitable proportions, renders completely insoluble the preparations of arsenic, zinc, and digitaline, but not the oxide of copper. It leaves in solution notable quantities of mercuric oxide and appreciable quantities of morphia and strychnia, and does not decompose or precipitate either the cyanide of mercury or tartar emetic. It completely saturates free iodine, but acts only partially on solution of the alkaline hypochlorites.

THE PRESERVATION OF ICE AT THE BEDSIDE.

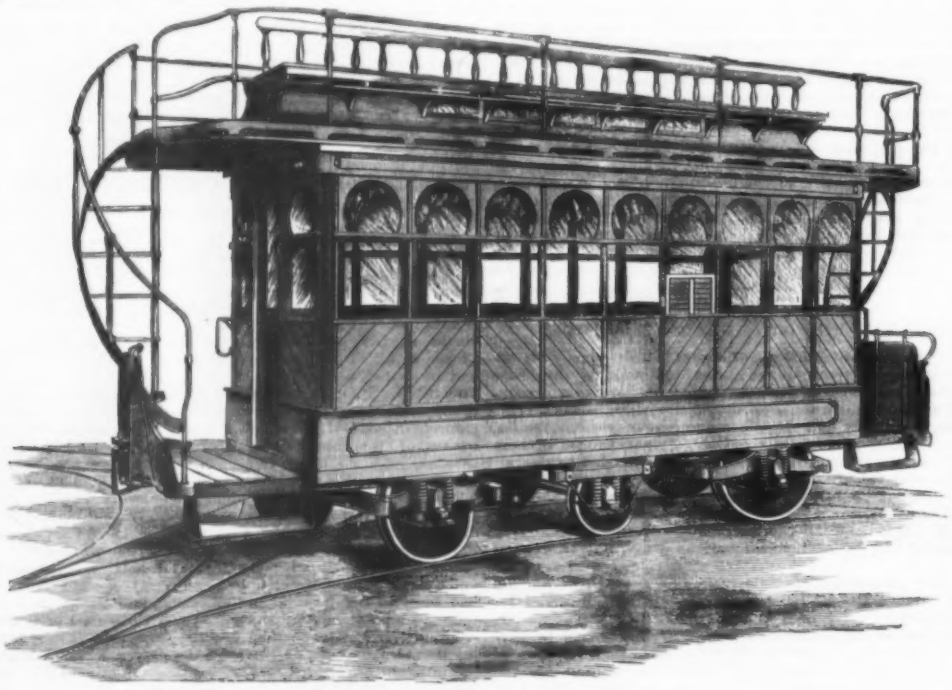
CUT a piece of flannel about nine inches square, and secure it by ligature round the mouth of an ordinary tumbler, so as to leave a cup-shaped depression of flannel within the tumbler to about half its depth. In the flannel cup so constructed pieces of ice may be preserved many hours—all the longer if a piece of flannel from four to five inches square be used as a loose cover to the ice-cup. Cheap flannel, with comparatively open meshes, is preferable, as the water easily drains through it, and the ice is thus kept quite dry. When good flannel with close texture is employed, a small hole must be made in the bottom of the flannel cup; otherwise it holds the water and facilitates the melting of the ice, which is, nevertheless, preserved much longer than in a naked cup or tumbler. A reserve supply outside the bedroom door can be secured by making a flannel cup, on the plan above described, in a pitcher, and filling it with little lumps of ice, care being taken that there is space enough below the bag to allow the water to collect and leave the ice dry. This provision will allow ice to be used during the hottest nights without the supply failing or the patient being disturbed—two very important considerations. The real therapeutic benefit of ice is only produced in some cases by its free use, and its soothing and stilling effect must be aided by the most perfect surrounding quiet.

FELIZET, of Elbeuf having observed that in epidemics of foot-and-mouth disease no beast affected with cow-pox is ever stricken with the former disorder, vaccinated thirty oxen, and not one of the twenty-five beasts effectually vaccinated showed any sign of foot-and-mouth disease, even after living for months among animals largely affected with it.

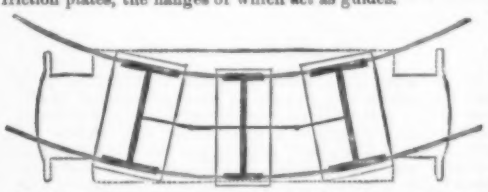
* This woman's father died with cancer.

A NEW STREET RAILWAY CAR.

THE peculiarity of these cars consists in the mode in which the wheels are mounted. There are three pairs, which are not fitted to the under-frame, but are so connected by an arrangement of movable frames of simple construction that they mutually control each other's position, and in such a manner that each axle is always held in the right position for rolling along the rail, whether straight or on the curve, and whatever the degree of curvature. Thus, when the car is traversing a straight line, the axles are held firmly in a parallel position, and when the car enters a curve are automatically shifted into a radial position, like the wheels on a turntable, and traverse the curve with the same ease. This action is made clear by the accompanying diagram, by which it will be seen that the leading and trailing trucks swivel on central pivots, and the middle truck is capable of lateral play in the friction plates, the flanges of which act as guides.



NEW STREET RAILWAY CAR.



The trial car (Muir's patent, London), which has been worked for some time in the regular daily service between Westminster and Greenwich, subjected to every possible test under varying conditions of weather, state of rails, and abnormal loading, has given results which are eminently satisfactory. Although the length of the wheel-base is more than double that of the ordinary cars, yet curves of 25-feet radius are traversed with the same ease and smoothness as a straight line. Owing to the fact that the trial car was built for use upon a steam tramway, its construction is somewhat heavier than would have been the case for ordinary work, and it carries a larger number of passengers than usual; yet, such is the reduction of tractive resistance, on the straight as well as on curves, obtained by this system, that the car pulls lighter and distresses the horses less than those in ordinary use. The long wheel-base, besides imparting great steadiness, affords also a good support for the under-frame of the car, and prevents the "hogging"—due to excessive overhang—which is so noticeable in ordinary tram-cars. Experience has entirely dissipated many doubts which were freely expressed as to the behavior of these tram-cars in passing the "open points," and in being put on or off the track, the facility with which they are handled proving them in every way superior to the rigid four-wheelers.

An important advantage of the invention is that it can readily be applied to the bodies of existing tram-cars, and that the expense is so small in comparison with the notable saving in horseflesh and wear and tear of rails and wheels. Indeed, the results achieved have amply justified the expectations previously formed.

EFFECT OF RAILWAYS IN MATERIAL PROGRESS.

COLORADO, which has just been admitted as the thirty-eighth State in the Union, is a remarkable illustration of railroad progress in the United States. Seven years ago not a mile of railroad track touched its rugged surface, and its borders could only be reached by weary days and perhaps weeks of journeying by ox-team or in the primitive stage wagon. Now its northern portion is touched by the Union Pacific Railroad, the great transcontinental highway. Another great trunk line, the Kansas Pacific, enters it near the middle of its eastern side, and a third grand enterprise, the Atchison, Topeka and Santa Fé, reaches it by the fertile southern line of the Arkansas valley. Local roads have climbed and penetrated the mountains in various directions, and the total length of lines in the State, all centring at Denver, is about 600. The peculiar adaptation of the narrow-gauge system to short curves and heavy grades was illustrated by the construction and successful operation, in Colorado, of the first three-foot gauge in the country, the Denver and Rio Grande, and several other lines are now in progress of construction or contemplated. The effect of the opening up of this distant region to easy communication with the rest of the world is seen in the rapid increase in population, by which it is now able to leave the probationary condition of a territory and claim a place among the sisterhood of States.

BRUSSELS HYGIENIC AND LIFE-SAVING CONGRESS.

THIS congress is announced to be held in the Ducal Palace from the 27th Sept. to the 4th Oct., 1876.

The programme has just appeared, and is divided into three sections—Hygiene, Life-Saving, and Social Economy.

FIRST SECTION.—HYGIENE.

This section comprehends—1. Public health and salubrity. 2. Hygiene, as applied to industry. 3. Domestic and private hygiene. 4. Medicine, surgery, and chemistry in relation to hygiene.

Questions Proposed for Discussion.

1. What are the advantages of water supply, and the best means of obtaining it in populous centres?

What is the effect of taking the water from hydrographic basins; and what is the consumption of water per head of the inhabitants?

2. Which is the most practical system of removing fœcal and putrescent matters and mud from towns? Means of purifying sewage, of utilizing drainage waters, of preventing the pollution of water-courses by the refuse of factories and works, and of neutralizing the bad effects of dungheaps near dwelling-houses; the choice of disinfectants and antiseptics.

3. How to ascertain easily and surely if death have taken place? Should permission to bury be preceded by examination by a competent person? Is the institution of the English coroner's inquest to be recommended?

What measures can be adopted which will be a guarantee against precipitate burial, without keeping corpses too long unburied? If mortuary depots be recommended, what is the best plan for them, and what are the precautions to be taken in the transport of the dead?

What are the advantages and inconveniences of ordinary burials, and of the various modes of cremation?

4. What are the causes of the excessive mortality of new-born infants and young children, legitimate and illegitimate?

Discuss the supply of nurses in great towns, and the subject of infants brought up by hand; the advantages and the inconveniences of the use of perambulators; the utility of special hospitals at the sea-side for scrofulous children, and the opportunity of establishing special schools for rickety children.

5. How is it possible to reconcile the interests of liberty and of the public health—(1) in the case of quarantine and lazarets; (2) in that of hydrophobia and other diseases which may be transmitted from animals to man? (3) What are the best precautions against spizotic diseases?

What are the precautions to be taken in the transport, killing, and burying of animals attacked by contagious diseases? Is cremation to be recommended in such cases?

What are the means of disinfecting stables, cattle-sheds, ships, wagons, and houses that are contaminated?

What are the rules to be observed in the transport of cattle intended for slaughter, as regards the public security and the health of the animals?

6. What are the best systems of heating and ventilating places to receive a great number of persons, such as factories, theatres, schools, hospitals, etc.?

7. What are the proper conditions of salubrity for (1) hospitals, infirmaries, and lying-in hospitals; (2) temporary hospitals and civil ambulances?

8. What are the means of obtaining—(1) uniformity in all countries in the statistics of mortality for the various professions and occupations, taking account of the habits of the working classes and of the substances with which they have to deal; and (2) of employing the means at the command of the State in obtaining such statistics?

9. What is the hygienic value of woods and plantations, and of the reclamation and drainage of marshes and other lands?

What are the means of preventing insalubrity in retting pits, rice grounds, and lands irrigated with muddy waters?

SECOND SECTION.—SAVING OF LIFE.

This section includes the means of saving life from fire, at sea, in railways, in mines, etc., and in time of war.

1. What are the means of preventing—(1) collisions on land and sea; (2) spontaneous combustion on board ship; and (3) of diminishing the cases of shipwreck and abandonment of vessels?

2. What additions are required to maritime codes and regulations for the security and comfort of passengers, especially in the case of emigrant ships and military transports?

3. What abuses exist in the system of maritime insurance, and how are they to be removed?

4. What precautions can be taken against extraordinary high tides and the sudden swelling of water-courses?

5. What are the means of preventing explosions and flooding in mines, and of diminishing their effects? What system of lighting mines presents the greatest security?

6. What are the means of preventing accidents in earth-work, and what are the best means of saving life in such cases?

7. How should life-saving committees be organized before or during war? (1) What is the duty of the State? (2) What staff and material are required? (3) What are the means of preventing such abuses as have appeared in late wars? (4) The federation of committees.

8. What should be the organization of the medical service on the battle-field during and after action?

9. What are the best means of transport from the battle-field—(1) to flying ambulances; (2) to temporary fixed ambulances; and (3) to hospital and lazarets?

10. What are the best modes of construction, installation, and management of tents and huts?

11. What care can be taken of corpses on the battle-field:—(1) Means of preventing marauding and other abuses; (2) Means of preventing or delaying putrefaction; (3) Temporary and definitive burial; (4) Cremation; (5) Institution of auxiliary corps of the "Black Cross"?

12. Question of wounded or stray animals on battle-fields.

13. What are the means of revictualling ambulances in war time? Requisitions, transports, gratuities, and rights and duties of convoys.

14. Organization of information in armies during campaigns. Offices, registers of wounded and killed, correspondence with families and with prisoners, and depots for property found on the battle-field.

15. Prisoners of war, aid, transport, and interments; conveyance home.

THIRD SECTION.—SOCIAL ECONOMY.

This section comprises institutions for improving the condition of the working classes.

1. To consider the conditions of private houses with regard to morals and health, aspect, heating, ventilation, lighting, water supply, and drainage.

To seek the economic solution of the above in relation to houses for the working classes, the best types and the best mode of enabling workmen to become owners; and to compare the results of co-operative and limited liability societies and private firms.

2. To what extent should instruction in gymnastics be introduced in primary and middle schools for girls and boys (1) in towns; (2) in the country?

3. To study the causes of the depopulation of country places, and seek means for remedying it. To ascertain the best method of combining the primary education of children and adults with industrial instruction of girls and boys in the country and in towns.

4. Danger of the abuse of intoxicating drinks, and modes of prevention. Statistics relating thereto. Are legal regulations necessary? And if so, to draw up a scheme of such law or regulation.

5. Examine the question of the labor of women and children in mines and factories. Is it necessary to regulate the conditions? If so, to draft a plan.

6. What is the organization of bureaux of information for workmen and employers, masters and servants? What are the results obtained by these institutions, and what improvements might be introduced?

7. By what means may the provident spirit be developed amongst the working classes? What are the peculiar functions of saving-banks, pension societies, life-insurance companies, mutual-aid societies, and co-operative associations? Examine the results of these various institutions.

8. What is the organization of arbitrations established in England, and of the syndical chambers of employers and workmen existing in France and Belgium? What results have flowed from these institutions?

9. In what manner can aid be best given to liberated prisoners?

Subjects Proposed for Conferences.

1. To discuss the report of the River Pollution Commissioners in England with regard to the oxidation of contaminated waters.

2. What substances can be found to take the place of lead and arsenical compounds employed in manufactures?

3. Means of preventing danger from petroleum—(1) in wholesale quantities; (2) in apparatus; or (3) as used for lighting.

4. The causes of boiler explosions, and the means of preventing them. To what authorities should boilers be submitted?

5. Medical regulations applicable to various occupations, for aid in case of accident. First thing to be done—(1) in the case of burns of various degrees, and caused by different means; (2) in cases of asphyxia from divers causes.

6. Means of preventing accidents on railways and tramways. Prevention of accidents and maladies in the case of engineers, stokers, guards, and others.

7. How to render the materials of shipping, houses, theatres, and powder magazines incombustible.

8. Means of rendering textile fabrics, and particularly those used for scenery and firemen's dresses, incombustible.

9. The use of steam in extinguishing fires.

10. Means of preventing accidents—(1) from poison in food; (2) from dangers caused by adulteration or corruption of food and drinks.

11. Organization of eating and lodging houses for workmen, without the introduction of the charitable element.

12. The moral and wholesome effect of the use of motors, adapted to small workshops and domestic purposes. The advantages, etc., of the sewing-machine.

13. In what way does treatment affect animals as regards their temper, their health, and the work they perform?

M. Auguste Couvedar is the secretary of the Congress, and his address is 17 Rue de la Pépinière, Bruxelles.

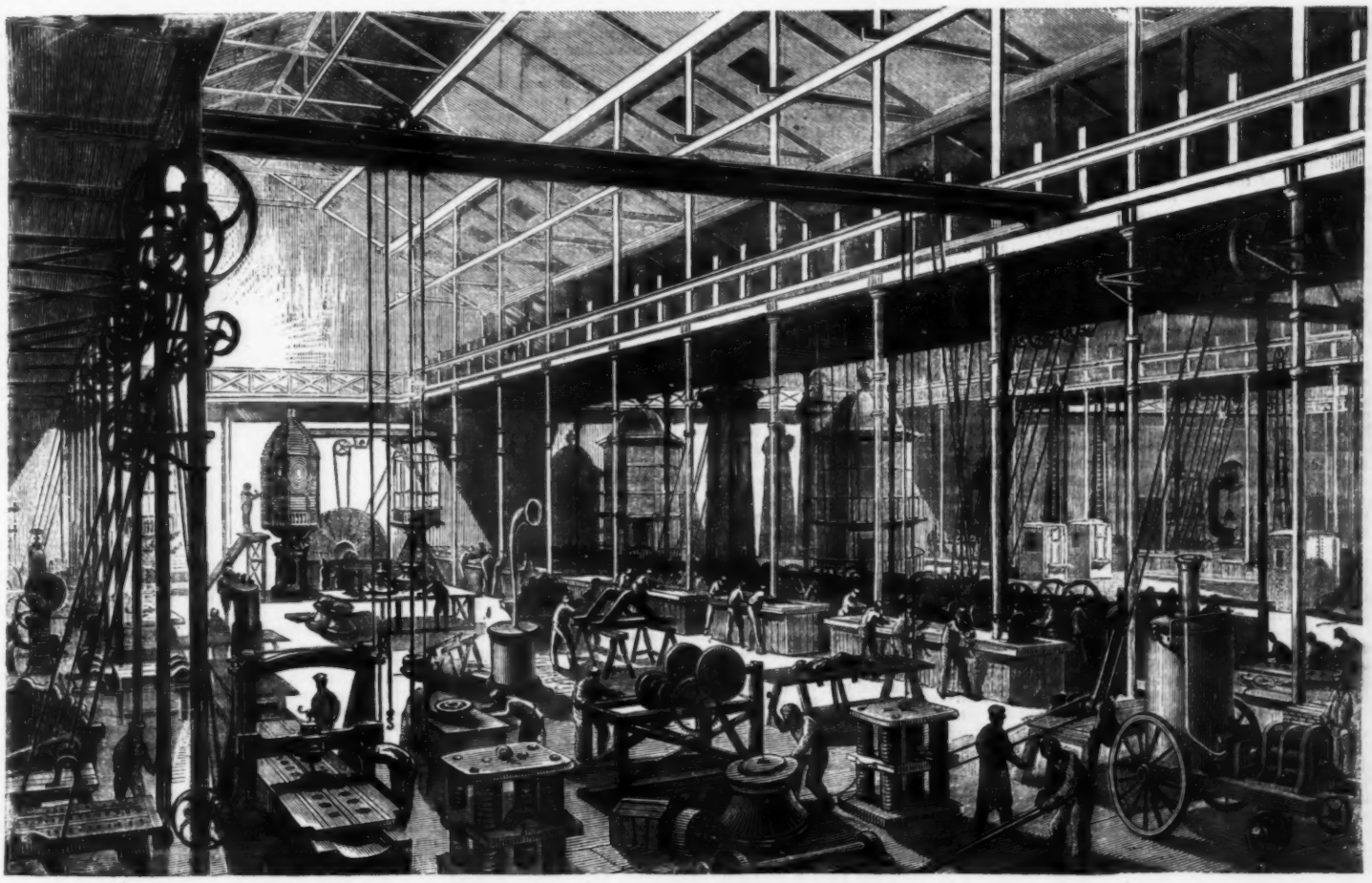
THE discovery that electricity has the effect of hastening germination is being turned to practical account in Italy, where silkworm eggs are being hatched ten or twelve days earlier than usual, by submitting them to a negative current from a Holtz machine for 8 or 10 minutes. At Padua, 40 per cent of caterpillars have been secured from the eggs thus experimented on.

ILLUMINATION BY THE ELECTRIC LIGHT.

SINCE the invention of the Gramme electric machine the electric light has come into extensive use in Paris as a means of illuminating depots, factories, and similar large edifices. The engraving, herewith presented, represents the shops of MM. Sautter & Lemonnier, builders of light-house lanterns, and will convey an excellent idea of the superior brilliancy of the electric lamp as compared with a multitude of gas-burners. The work-room includes two bays or sections, each 96 feet long by 80 feet wide. The area between these is 32 feet wide. On the lower floor are the machine tools, and in the story above the pattern-makers and moulders work. Three Gramme machines each support a light equal to 100 burners, and the three lamps illuminate all the shops sufficiently to admit of the use of machines of precision requiring delicate adjustments. The shadows produced by one lamp are neutralized by the other two, so that work may be carried on in any part of the shop.

The three electric machines are located in the engine-room, and are driven at the rate of from 850 to 900 turns per minute. One lamp is placed in each of the bays, where the machine tools are located, and the third in the boiler-room. They are suspended at a height of 27 feet above the floor, and each is attached to a carriage which moves on an iron beam of the roof.

The relative cost, as compared with gas, of the electric light is given as follows: During one month the three machines were used 120 hours—equivalent to 360 hours with a single apparatus. During this period there were expended 84.6 feet of carbons, 2904 pounds of coal, besides wages of men in charge, oil, waste, etc., the whole amounting to $17.13, or about 14 cents per hour. This illumination replaced 115 gas-burners consuming 426 cubic feet of gas per hour, at a cost of 72 cents, showing a difference of 58 cents in favor of the electric light. The cost of the three sets of apparatus, including all attachments, was $1269. Supposing that there is a deterioration of 10 per cent in the machinery for every 1000 hours' usage, a reduction of about 13 cents from the above saving must be made, when there will still remain an economy over gas of 45 cents per hour. These figures are, of course, based on Paris prices, and would probably differ greatly in this country. They will, however, serve to convey a relative idea of the economical value of the system.



CONDUCTION OF ELECTRIC CURRENTS.

IN the passage of electrical currents through electrolytes, M. Du Bois Reymond happened to observe that the strength of current is different in the two opposite directions, when the electrodes are of different size. This phenomenon, which has been denoted by the name of "irreciprocal conduction," has been made by M. Christiani the subject of a special investigation. He finds it to be most pronounced, where a fine metallic point and a plate standing opposite it are employed as electrodes, and he names the direction from the plate to the point the "platydrom," the opposite direction the "oxydrom."

For a study of the phenomenon, a concentrated solution of Cl Na is specially suitable, along with electrodes of platina. It is further best to employ the single-induction currents of a sliding inductorium; they are sent simultaneously through the liquid and through a galvanometer. Being of momentary duration they produce no marked decomposition. In this way, then, the rule is demonstrated, that weak currents are stronger in oxydromal direction, while stronger currents are stronger in platydromal direction, than conversely. Thus currents of less density go more easily from the point to the plate currents of greater density more easily from the plate to the point.

In every combination there is a determinate mean strength of current, with which in both directions the current appears of the same strength. This point, which is named the "reciprocal point," has a very constant position when, in the same combination, *ceteris paribus*, only the distance between the electrodes is altered. It is found, viz., that the reciprocal point always occurs with one and the same distance of the secondary coil. If, on the other hand, resistances be introduced into the metallic circuit of the induction current, we must seek a shorter distance of the secondary coil, in order to obtain the reciprocal point, and it appears that this point always corresponds to one and the same tension of the electrodes. In a given mixed circuit, therefore, with electrodes of unequal size, the conduction occurs reciprocally only with a quite determinate electro-motive force. It follows, that the irreciprocal conduction is a function of the tension of the electrodes.

The position of the reciprocal point is further, *cet. par.*, dependent on the size of point (of the one electrode); with diminution of the latter, the former sinks to smaller current values. These phenomena occur in the same manner in a large number of electrolytes, with use of different metallic electrodes. Since, moreover, they occur with quite unpolarizable combinations, *e.g.*, with zinc electrodes in zinc vitriol solution, irreciprocal conduction can not depend on polarization. The examination of different electrolytes brings to light an important relation between the position of the reciprocal point and the molecular weight of the decomposed substances. If, viz., that position be denoted by a number, the "dysodic constant," which is obtained by dividing the strength of the current sent through a metallic circuit by the reciprocal current in the electrolyte, it appears that this is nearly proportional to the molecular weight. With some combinations, however, multiples of the molecular weights must be taken, in order to establish the law.

M. Christiani develops, in closing, a theory of electrolysis, in which he seeks to explain irreciprocal conduction and the discovered molecular law. According to this theory, we are to conceive that the electricity in the solutions is transported from one electrode to the other, not at all by the water, but only by the ions, and that only in one direction, from the anode to the cathode. For further exposition of the theory, we must refer to the original.—*Der Naturforscher.*

THE NATURE OF THE ZODIACAL LIGHT.

THE zodiacal light, as is known, is a faint nebulous aurora accompanying the sun, and visible immediately before sunrise or after sunset: it was first observed by Kepler. It has a flat lenticular form, and is placed obliquely in the horizon, the apex extending to a great distance in the heavens. Its direction is in general nearly in the plane of the sun's equator; hence it is scarcely visible in our latitudes, except at particular seasons, when that plane is nearly perpendicular to the horizon. Among various explanations that have been given of the phenomenon, Cassini thought it might be caused by the confused light of a multitude of small planets circulating round the sun. Another hypothesis, which Laplace disposed of, was that which ascribed it to the atmosphere of the sun. It has generally been supposed, in the present day, that it forms the outer part of the solar corona.

In a recent number of the Proceedings of the Reale Istituto Lombardo, the numerous observations of the zodiacal light by Jones have been subjected to careful examination by M. Serpieri, and he arrives at the conclusion that the light is an electrical aurora preceding and following the sun round the earth.

As the northern light is a local phenomenon, connected with the hour of local time, so also is the zodiacal light, which coincides with the hours which follow the setting, and precede the rising, of the sun.

The so constant phenomenon of the phases of rising (in the evening) and of sinking (in the morning) of the apices of the zodiacal cone, evident from Jones's drawings, demand absolutely (says M. Serpieri) the explanation referred to. When the cone is grown to a maximum in one place, it is at other places in the beginning of its rise. There are, therefore, just as many zodiacal cones as there are horizons. Similarly, Donati found there were just as many polar lights on Feb. 4th, 1874, as there are degrees of longitude from the furthest parts of Asia, through Greenwich, on to America.

As a local meteorological phenomenon, the zodiacal light has different forms, inclinations, and sizes, in different lands. The differences the author has met with in this respect he is unable to explain by parallax. On one and the same day, Heis in Münster has observed the axis inclined to the North, and therefore the apex appearing simply north of the ecliptic; while Jones in Rio Janeiro saw the axis inclined southwards, and the apex south of the ecliptic.

The hypothesis of a solar reflection he also excludes on account of the spectroscopic characters of the zodiacal light, which also appear to him to favor his explanation.*

The annual curve of elongations of the apices shows their maxima to be in and after the solstices, and the minima in and after the equinoxes; that is, the maxima at epochs in which the earth goes through the nodes of the sun's equator, and the minima when we are at the greatest distances from the sun's equator. Perhaps, the author suggests, the electric currents of the sun which go to the earth, and produce the zodiacal and polar lights, when they are in the positions given in reference to the horizon, are greater in the first epoch, less in the other. He further offers proof that these maxima and minima of the elongations of the apices do not depend on the portions of the zenith relating to the ecliptic.

The phenomenon of pulsations, certainly observed by Jones, seems to indicate still further a dynamical state of the great zodiacal cone, which is fed by continual radiations—radiations which appear intermittently, if the resistances increase, and produce the pulsations; with which is associated not a greater, but a smaller development of the cone than usual.

This new conception of the zodiacal light opens a whole field for further investigations and theoretical speculations. M. Serpieri's communication is merely of a preliminary character, and he hopes shortly to publish further results of his inquiry.—*The Telegraphic Journal.*

THE RADIOMETER.

THE following curious experiment with the radiometer has been lately made by M. Ducretel. When it is rotating as usual in ordinary daylight, some ether is poured on the envelope; the direct rotation stops, and inverse rotation occurs. This reaction presently ceases, and the vanes resume the original direct rotation, notwithstanding the evaporation kept upon the envelope by light sprinkling of ether. The rotation now, however, becomes faster than at the first, the evaporation apparently acting like a source of heat, though it perceptibly cools the envelope. When the sprinkling of ether has stopped, the movement resumes its nominal velocity, and remains direct. M. Ducretel also tried the effect of phosphorescent powders presented before the radiometer in darkness, after they had been exposed to sunlight; but the instrument showed no motion. The chief objection brought against the emission-theory explanation is that the white face, reflecting the light and behaving like an elastic surface, should be more strongly repelled than the black. M. Giffard illustrated this by letting a small piece of agate fall from a constant

* Professor A. W. Wright, whose researches on this subject are well known, says, on the contrary, that the zodiacal spectrum varies but little from the solar spectrum except in length; and he expressly attributes the zodiacal light to the reflection of the sun's rays from small meteoric bodies.

height on one plate of a balance. The depression is much greater when the plate is of annealed steel—that is, elastic or like the white face—than when it is of copper and like the black. But M. de Fonvielle remarks that this is supposing the velocity of the shock is not superior to the velocity of propagation of the molecular movements. A revolver ball makes a hole in a pane of glass because the molecules directly s ruck have not time to communicate their motion to neigh boring molecules. Now the luminous molecules have a velocity vastly greater than that of the ball. And it is really the degree of absortion, other things equal, that must rule the velocity of propulsion.

METHODS OF CHEMICAL DECOMPOSITION AS ILLUSTRATED BY WATER.*

By Prof. J. H. GLADSTONE, Ph.D., F.R.S.

IN 1781 Cavendish found that when a mixture of what were then called "inflammable air" and "dephlogisticated air" is exploded by a spark in such proportions that the burnt air is almost entirely phlogisticated, pure water condenses on the sides of the vessel, and is equal in weight to the weight of the two airs. His theory was that water consists of "dephlogisticated air united to phlogiston," and that "inflammable air is water united to phlogiston." At the time of explosion, according to him, the excess of phlogiston was transferred from the inflammable to the phlogisticated air, and thus both airs "turned into water." Cavendish also explained Priestley's production of inflammable air on heating iron filings strongly, by contending that the phlogiston of iron united with the moisture from which they had not been freed. Lavoisier gave a different explanation of these phenomena. He held that "dephlogisticated air" is an elementary substance—oxygen—united with imponderable caloric, and that "inflammable" air, or hydrogen, is capable of taking the oxygen from the caloric, thus producing water and heat. "Water is not a simple substance, but is composed, weight for weight, of inflammable and vital air." Thus water was at length deposed from its rank as an element.

DECOMPOSITION BY ELECTRICITY.

In the first year of this century, when the news of Volta's great discovery of the pile was made known in England, Messrs. Nicholson & Carlisle made various experiments with a series of half-crowns, zinc plates, and pasteboard soaked in salt. Knowing that water conducted electricity, they inserted brass wires through corks at the two ends of a tube filled with water, which they are careful to tell us came from the New River. They were surprised to see a stream of minute bubbles rising from one pole, while the other was corroded, and that this decomposition took place at each pole, though they were nearly 2 inches apart. They enlarged the distance, and found that 36 inches of water was too much for their force to traverse. Substituting flattened platinum for their brass wires, they found that the water was decomposed with the production of hydrogen at one end and oxygen at the other.

The old notion that water, by continuous boiling, was turned into stone, had been previously dispelled by Lavoisier, but Davy found that some salts and earths remained behind when water was electrolyzed, and that when the experiment was conducted in two cells communicating with one another, the liquid in the one cell became acid and the other alkaline. He traced the origin of this in a masterly research, which formed the Bakerian lecture for 1806.† He found that the earthy substances were original impurities in the water, or came from the vessels employed; and using gold cones filled with distilled water and united together by asbestos, he convinced himself that nitric acid was produced at the positive pole and ammonia at the negative. Suspecting that these were produced from the small quantities of nitrogen dissolved in the water combining with the liberated oxygen and hydrogen respectively, he took extraordinary precautions. Making use of water which he had carefully distilled in a silver still at 140° F., and performing the experiment *in vacuo*, or rather in a space which he had twice filled with hydrogen and exhausted as thoroughly as the means at his disposal would permit, he then found that the water was decomposed, without the least production of either acid or alkali. "It seems evident, then," wrote Davy, "that water, chemically pure, is decomposed by electricity into gaseous matter alone, into oxygene and hydrogene."

DECOMPOSITION BY CHEMICAL AFFINITY.

In the following year Davy discovered the metals of the alkaline earths, potassium and sodium, and found that when these bodies are thrown upon water they decompose it, appropriating its oxygen and setting free its hydrogen. This is due to the superior chemical power or "affinity" of the alkaline metals.

DECOMPOSITION BY HEAT.

In 1846 Mr., now Sir William, Grove observed that when steam was subjected to something like a white heat, small quantities of mixed oxygen and hydrogen gas were always produced.‡ It has since been shown that the gases are actually dissociated in one part of the flame of the oxy-hydrogen blowpipe, after their first combination.

It thus appears that there are three distinct ways in which water may be decomposed: by an electric current;§ by some substance which has a superior attraction for one of its elements; or by heat alone.

It will readily be understood that the power of any one of these agents will be augmented by the co-operation of either of the others. Thus, the action of chemical affinity is usually augmented by heat; for instance, if a pellet of sodium be thrown upon cold water it melts, on account of the chemical action at once set up; but if upon boiling water, it not only melts, but bursts into flame through the greater violence of the action. This is the reason why, in Priestley's experiment, iron at a red heat decomposed steam, though it will not do so at ordinary temperatures.

Similarly the electrolysis of water is much facilitated if there is some chemical affinity between the oxygen and the metallic conductors. It is generally said that it requires two cells to decompose water electrolytically. Now, it is true that if platinum poles are employed, there is no visible disengagement of gas when one cell only is used; but with zinc poles a single cell of Bunsen or Grove is amply sufficient. Zinc alone without the voltaic current is incapable of displacing the hydrogen in water; but it must be borne in mind that the tendency to combine with oxygen is a constant property of this metal, and is easily brought into activity by the co-operation of the feeble voltaic current. The increased effect upon electrolysis which is due to the nature of the poles is in proportion of the electromotive force of the different metals. For pure water the order is: zinc, lead, iron, copper, silver, platinum, as tested by a galvanometer. This difference of result, according to the nature of the metals employed in the electrolytic cell, appears generally to have been overlooked, and it is the feeblest metal—platinum—which is usually employed for experimental purposes, doubtless because it is incapable of oxidation—the very reason of its feebleness.

When the other metals of the above list are used, not only does the positive pole oxidize, but the oxide, or rather hydrate, dissolves more or less in the pure water, and becomes itself an electrolyte. The consequence of this is that the positive electrode gradually wears away, while the metal is transferred to the negative electrode, and is deposited upon it in crystalline fringes or filaments. With silver these are particularly beautiful, as they assume arborescent forms, especially when able to spread over the surface of the containing vessel.

The temperature also of the liquid subjected to electrolysis has a great influence upon the result. Thus in an experiment where zinc poles and pure water were employed, the deflection of a galvanometer was found to increase about fourfold between 5° C. and 80° C., and the action augmented nearly *pari passu* with the temperature.

A similar result occurs, as might be expected, when two dissimilar metals, such as zinc and copper, are placed in cold water in connection with one another, and the water is heated. The deflection was found to double between about 30° and 80° C., but the difference for every 5° at the higher temperatures was several times greater than at the lower ones.

Another very important point in the electrolysis of water is to reduce to a minimum the very great resistance offered by the water itself. This is effected by bringing the electrodes as near to one another as possible; and for the same reason, if the force be generated by the action of two dissimilar metals upon water, they should be brought into the closest proximity.

A still more powerful means of decomposing water would evidently be a combination, not of two, but of all three agents, chemical affinity, heat, and voltaic force, acting at an insensible distance. Thus zinc has a strong affinity for oxygen, but is unable of itself to displace the hydrogen of water; when united, however, with a more negative metal, such as copper, its power is enhanced to such a degree that a separation of the constituents does take place; but in the ordinary arrangement of a voltaic cell the action is so slight that no evolution of gas is perceptible. To produce a visible effect, the metals must not only be close together, but ought to touch one another at a myriad of points. This may be brought about by depositing the copper upon the zinc in a spongy condition; then the zinc will be oxidized, and bubbles of hydrogen will appear among the branches of the copper, even at the ordinary temperature, but the effect is greatly increased by the application of heat.

THE COPPER-ZINC COUPLE.

The arrangement just described is the "copper-zinc couple," which has been employed by Mr. Tribe and the speaker, and more recently by others, to effect a variety of chemical decompositions. Zinc foil is immersed in a solution of sulphate of copper until a black velvety deposit of the metal is produced; the soluble salts are then washed away, and the couple, after being dried, is ready to be placed in any liquid it is desired to decompose. Water was the first body experimented upon, and it was found that the action would go on as long as there was any metallic zinc left in union with the copper, the amount of hydrogen evolved gradually diminishing, though varying somewhat with the temperature of the day. The great influence exerted by heat is, however, better shown in the subjoined table, which gives the results of an experiment reduced to the unit or an hour's work:

At 2·2° C.	.....	1·1 c.c. of hydrogen produced.
22·2° "	.....	5·5 " " "
34·4° "	.....	13·9 " " "
55·0° "	.....	62·0 " " "
74·4° "	.....	174·6 " " "
93·0° "	.....	528·0 " " "

These figures strikingly exhibit the rapid acceleration of the action at the higher temperatures.

A greater effect may be produced by substituting for the copper a still more negative metal. Thus a zinc-platinum couple acts with much greater energy upon water. Gold-zinc couples, and many others also, have been tried, but gold has the practical disadvantage that the precipitated metal does not adhere well to the zinc. Aluminium alone does not decompose water—not even, according to Deville, at a red heat; but an aluminium-copper couple decomposes it slowly, and an aluminium-platinum couple more rapidly, even in the cold. One of the most recent discoveries is that aluminium when amalgamated with mercury is converted into hydrate, even by the moisture of the air. The most powerful combination, however, might be expected to be that of the most positive and the most negative metal which can be conveniently brought together. These are magnesium and platinum; and in fact if strips of magnesium foil be coated with finely-divided platinum by immersing them in platinic chloride, and the resulting salts be washed away, a couple may be obtained which produces a most vigorous evolution of hydrogen when it is placed even in cold water.*

The decomposition of water by the copper-zinc couple was, of course, a matter of little practical importance; it does, however, yield hydrogen in a state of purity, even though the zinc be largely contaminated with such a substance as arsenic—a fact which may prove of great consequence in medico-legal inquiries. These observations on water led to a long series of experiments on other bodies, especially organic compounds. The action of the two metals in conjunction frequently effects not only the splitting up of a compound, but a re-distribution of its elements; and this has resulted not only in the discovery of a simple means of producing various substances previously known, but the formation of several others hitherto unknown. Thus the first trials were made on iodide of ethyl, in the hope that Prof. Frankland's beautiful process for making zinc ethyl might be simplified; and not only was a better result obtained in a shorter time, but when the experiment was performed in the presence of alcohol it was found that pure hydride of ethyl was given off, and a new substance, the iodoethylate of zinc, remained in the flask.

Among the bodies which may be prepared more easily or in greater purity by the copper-zinc couple are the following:

Hydrogen.	Olefiant gas.	Diallyl.
Methyl hydride.	Acetylen.	Zinc ethiodide.
Ethyl hydride.	Propylen.	Zinc ethyl.
Propyl hydride.	Diamyl.	Zinc amyl.
Amyl hydride.		

The substances that have been discovered by this agency are the following:

Zinc propiodide	$Zn(C_3H_7)I$.
" propyl	$Zn(C_3H_7)_2$.
" isopropyl	$Zn(C_3H_7)_2$.
" ethylobromide	$Zn(C_2H_5)Br$.
" iodoethylate	$Zn(C_2H_5O)I$.
" bromethylate	$Zn(C_2H_5O)Br$.
" chlorethylate	$Zn(C_2H_5O)Cl$.

Zinc propyl is a volatile liquid body, of sp. gr. 1·908, which takes fire spontaneously in the air, burning with a bluish white flame. The haloid ethylates are a new class of bodies which have been prepared from both ethyl iodide and iodoform, and their corresponding bromine and chlorine compounds.

The couple has also thrown some light upon the chemical structure of some of these organic bodies, as, for instance, by its different behavior with the two isomeric bodies, chloride of ethylen and chloride of ethylidin. This is a direction in which future investigation is likely to be rewarded.*

NITRATES IN WATER.

This method of quietly bringing about a chemical change has found a practical application in the hands of Prof. Thorpe for determining the amount of nitrates in samples of water—a question of great importance, which has hitherto been also one of great difficulty. The nitric acid is reduced by the couple to the condition of ammonia. In a similar way chlorates are reduced to chlorides.†

The progress of research by means of the copper-zinc couple was interrupted by the discovery of a curious reaction, by which also water and other substances may be decomposed. Metallic aluminium does not attack water by itself, neither does iodine; but if the three are brought into contact, oxide of aluminium is formed and hydrogen gas is evolved; and not only this, but the solution so produced will cause the oxidation of any excess of aluminium with the formation of an equivalent amount of hydrogen. It is not even necessary that free iodine should be employed, for iodide of aluminium itself will determine the oxidation of any amount of metal. This action is greatly quickened by coupling platinum with the aluminium. By employing alcohol instead of water a similar action is set up, and this has led to the discovery of aluminium ethylate, $Al_2(C_2H_5O)_6$, alcohol in which the replaceable hydrogen is substituted by aluminium. It is a solid body at the ordinary temperature, but easily melts, and is capable of being sublimed unchanged, its vapor burning with a luminious flame and white smoke of the oxide of metal. Other compounds prepared by this singular reaction, and the nature of the chemical changes which occur, are at present the subject of study. ‡—*Chemical News.*

THE UNION OF CHLORAL HYDRATE AND CAMPHOR.

By ERNEST C. SAUNDERS, Montreal.

IT has long been known that a mixture of hydrate of chloral and camphor, in equal parts, formed a liquid, but it has, I believe, never been settled as to whether the result is due to chemical combination or to the solvent power of one article over the other. The following notes of an investigation into the subject may be interesting, and throw some light upon it.

Four ounces of chloral hydrate and the same weight of camphor, in lumps, were put into a bottle and allowed to stand, being occasionally shaken. In forty-eight hours both were completely liquefied, forming a syrupy fluid, smelling of both ingredients, and of specific gravity 1.243. Five ounces of this were placed in a flask, fitted with a wide tube leading into a receiver immersed in ice-cold water, and having a thermometer passed through the cork, the bulb reaching into the liquid. Heat being applied, the temperature rose to 224° F., at which point the liquid boiled freely. The temperature rose gradually up to 300°, from which point it rose more rapidly to 402°, when the liquid distilled unchanged. The distillate was separated into two parts, the first being collected up to 300°, the other being that which passed over between that point and 402°. The vapor which passed over at this temperature solidified in the tube before reaching the receiver.

The first distillate was a soft greenish mass, consisting of small crystals mixed with liquid. It was found to consist of chloral hydrate, with a very small quantity of camphor, and owed the color to a minute quantity of a greenish oil, apparently the result of some chemical action having taken place between the chloral and camphor. This oil could not be obtained in sufficient quantity to be examined.

The second distillate was a thick oily liquid, having a pungent odor of chloral hydrate. It combined with a small proportion of water, but was insoluble in a larger quantity. It was miscible with alcohol, of specific gravity .937 and .838 in all proportions, and proved to be hydrate of chloral with about enough camphor to liquefy it.

The residue in the flask, which boiled at 402°, was found to solidify at 248°, and was almost insoluble in water, but freely soluble in alcohol, sp. gr. .838, was plainly camphor.

The original solution was decomposed by water, the camphor floating on the surface, while the filtered liquid gave abundant evidence of chloral hydrate on being tested.

Judging from these facts, it would seem certain that no chemical action takes place when the two articles are mixed in the cold. Both are volatile at ordinary temperatures, and

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* A lecture delivered at the Royal Institution of Great Britain, Friday, May 5th, 1876.

† *Phil. Trans.*, 1807, p. 1.

‡ *Ibid.*, 1847, p. 1.

§ Though voltaic electricity alone is referred to in this discourse, it is well known that other forms of the same agent will effect chemical decompositions. Thus Prof. Andrews has resolved pure water into its constituent gases by frictional electricity, and by that derived from the atmosphere.

* Phenomena resulting from different metals in combination have frequently been observed by several experimenters, and some of them are described by Mr. W. N. Hartley in the *Chemical News* (vol. xiv., p. 73); but it does not appear that the metals have ever been freed from concomitant salts, or their action understood or appreciated.

* Further particulars respecting the decomposition of water by this special kind of electrolysis may be found in *Proc. Royal Soc.*, 1872, p. 218; *Report Brit. Assoc.*, 1872, Abstracts, p. 75; *Journal Chem. Soc.*, 1873, p. 432; *Phil. mag.*, 1875, pp. 284, 285. The account of "Researches on the Action on the Copper-Zinc Couple on Organic Bodies" is given in the *Jour. Chem. Soc.*, 1873, pp. 445, 678, 961; 1874, pp. 30, 406, 410, 615; 1875, p. 508. See also vol. vii. of *Proc. Roy. Inst. of Great Britain*, p. 521.

† *Jour. Chem. Soc.*, 1873, p. 541.

‡ Since this discourse was delivered, this peculiar reaction has been elucidated in a paper read before the Chemical Society, on "The Simultaneous Action of Iodine and Aluminium on Ether and Compound Ethers." An intermediate body, the aluminium iodoethylate, $Al_2(C_2H_5O)_4I_2$, is there described.

the following experiment, which was performed to ascertain which was the solvent, conclusively proves that it is the vapors which act upon each other. Two lumps, one of chloral hydrate and one of camphor, were placed about an inch apart on a porcelain plate, and covered with a bell glass. In fifteen minutes the surface of the camphor was quite damp, but the chloral was quite dry. In three hours the chloral was still dry, whilst the camphor was quite wet and standing in the midst of liquid. In twelve hours the liquid had reached the chloral, the upper surface of which was still dry. While in twenty hours both lumps were half liquefied, and the inner surface of the bell glass was covered with moisture. This would almost seem to point out that the vapor of the chloral was the solvent, but it was found while one part of camphor would form a permanent liquid with three and a half parts of chloral hydrate, one part of chloral dissolved by the aid of heat with two parts of camphor solidified to a soft crystalline mass when cold, from the camphor crystallizing. It is most probable that the camphor is the solvent, which would also seem likely, as camphor is an essential oil, and is known to render other bodies fluid. The change of color, with the formation of an oily liquid, would seem to point to chemical action occurring when the mixture is subjected to strong heat.

The following notes of the solubility of the mixture in various articles may be serviceable to any who are called upon to dispense it, or to physicians who feel inclined to try the effects of it.

It is miscible in all proportions with alcohol, sp. gr. .834, bisulphide of carbon, ether, and olive oil. It is soluble in eleven parts of alcohol, sp. gr. .936. It is insoluble in water. It forms a clear mixture with one and a half parts of chloroform, but a further addition of three parts of chloroform renders it turbid. Camphor forms a permanent liquid with three times its weight of chloral hydrate. The experiments were conducted with the atmosphere at a temperature of about 80°; the fact is mentioned, as it may have influenced the solubility slightly.

INFUSORIA AND NITRATES.

By T. L. PHIPSON, Ph.D., F.C.S., &c.

SOME very interesting observations regarding the reduction of nitrates by bacteria have recently been made by M. Meusel. It has been long believed that the nitrites found in waters are due to the oxidation of ammonia, but the author just named has proved in a satisfactory manner that they are not necessarily so produced. Water containing no compound of nitrogen except some alkaline nitrate was found after a certain time to contain no nitrites: this reduction was the effect of numerous bacteria visible in the microscope. It was stopped at once by phenol, salicylic acid, benzoic acid, alum, and salt. The following experiment shows under what circumstances this phenomenon occurs:

A little pure water, containing some bacteria, has an alkaline nitrate added to it. At first there is no reduction, but after the addition of certain organic substances, more especially carbohydrates, such as sugar, etc., nitrites are produced at once and rapidly. Recently distilled water mixed with sugar and a little alkaline nitrate, then boiled in a long-necked flask, the end of which is closed during ebullition, showed no reduction after many weeks.

The conclusions drawn from these experiments are: That the nitrites found in ordinary waters are due to bacteria; that bacteria are the agents of the transmission of oxygen, even when this substance is combined, and that this is probably the reason they are so dangerous to man.

On repeating these experiments with very dilute solutions of permanganate of potash, without the addition of any organic substance, I find the bacteria killed simultaneously with the reduction of the salt. I have also found that when a little too much nitrate of potash exists in the water no reduction takes place, and the bacteria are also rendered immovable.

Now M. Meusel has also asserted that nitrates are useful as manure, not only by the nitrogen they contain, but on account of the oxygen they supply to bacteria, which enables the latter to destroy cellulose, etc. If this is the case, it would appear, at first sight, that nitrate of soda would prove a more valuable manure than sulphate of ammonia. But not long since I applied sulphate of ammonia and nitrate of soda to two small plots of the same pasture-land in such quantities as to supply *the same amount of nitrogen* in each case. 8½ cwts. of nitrate of soda and 6½ cwts. of sulphate of ammonia were used in this experiment, and the result was as nearly as possible identical in both cases. As with the bacteria, when either substance was applied in excess the grass was killed, and turned brown or yellow within three days. When applied in the most favorable proportions, the yield in both cases was almost identical. Now 6½ cwts. of sulphate of ammonia supplies no available oxygen, whilst the 8½ cwts. of nitrate of soda supplied about 1½ cwts. of oxygen, the quantity of nitrogen being the same. Yet there was no apparent result for this difference of oxygen.

Now, if M. Cloëz's theory is true, that C, H, and N are assimilated by plants as CO_2, HO, and NO_5, and that NH_3 in the soil or the manure becomes NO_5 to be assimilated, then the *atmosphere* would have supplied to the sulphate of ammonia the extra 1½ cwt. of oxygen in question. This, of course, would require rather more time, and such, in fact, was the case in my experiments, the nitrate being the quickest of the two by about eight days.—*Chemical News.*

NEW METEORIC MINERAL, DAUBREELITE.

PROF. J. L. SMITH has discovered a new meteoric mineral, of which he says: I have thought proper to designate it after M. Daubrée, who has done so much in the study and elucidation of meteoric minerals. It is found on the meteorites from the Mexican desert.

Daubréelite is a black lustrous mineral, highly crystalline in structure, occurring on the borders of the troilite nodules, and sometimes running across the centre of them, as may be seen in one of the specimens, where, in a nodule of troilite, a vein of the mineral traverses the very centre of the nodule, which is two millimeters in width and twelve millimeters long. It has a distinct cleavage, but I can not make out its crystalline form. It is very fragile, and in the attempt to detach it from the iron, it breaks up into small fragments resembling small particles of molybdenite. It is feebly attracted in very fine particles when a strong magnet is brought in contact with it. This may arise from the presence of a minute quantity of troilite which it is very difficult to get rid of. Pulverized, it furnishes a perfectly black powder, the smallest particle of which gives before the blowpipe a very strong reaction of chromium. Heated very intensely, it loses its brilliant color and becomes a dull black.

The powdered mineral is dissolved completely in nitric acid. The solution is intensely green, and furnishes a strong reaction of sulphuric acid and oxide of chrome. The other strong acids attack it but slightly.

This solubility in nitric acid readily distinguishes it from chrome iron.

The following would express its true composition: Sulphur, 37.62; chrome, 62 38.

This mineral is an interesting one, and is found in a very strange place, yet from what is revealed to us by the spectroscope with regard to the vapors surrounding the sun, the element chrome must be widely diffused in the matter of the universe.—*American Journal of Science and Arts.*

ERYTHROGEN.

By LEWIS THOMPSON.

To make erythride of potassium, we must begin by making an amalgam of potassium, consisting of about 1 part by weight of potassium and 150 of mercury, which is easily done by fusing them together under naphtha. When cold pour off the naphtha, and having wiped the surface of the amalgam with a dry cloth, transfer it as quickly as possible to a dry stoppered bottle, and add to it a quantity of bisulphuret of carbon equal to about three times the weight of the potassium employed; then shake the whole well together until the mixture becomes solid, when it must be set aside for a few hours to cool and complete the combination. After this, the surplus bisulphuret of carbon is to be driven off by a current of air, and the erythride of potassium separated from the mercury by water and filtration in the usual way. But it is worthy of notice that a part of the mercury, under the influence of the potassium, is converted into erythride of mercury at the same time, and this holds out a hope that such metals as lead and antimony in a very minute state of subdivision may be useful in purifying coal-gas from bisulphuret of carbon; and in fact I am now actually trying the pyrophoric mixture of lead and charcoal formed by heating the tartrate of lead, and it seems to promise well. When the hydro-erythric acid is thrown down by acids from the solution of erythride of potassium, much of it is decomposed in carbonic acid and sulphuretted hydrogen, except at a very low temperature; but in either case it forms a fixed, chocolate-red, granular powder, most remarkably like selenium.—*Chemical News.*

TEMPERATURE OF SOLIDIFICATION OF SULPHUR.

By M. D. GERNEZ.

THE author remarks that the slowness with which a body melts in a bath of a constant temperature little above its point of fusion, and the imperfect conductibility of the substances, which enables certain portions of the liquid to reach temperatures higher than those of the part not yet melted, have induced experimentalists, instead of the point of fusion, to determine the point of solidification, *supposed* to be identical, in which case, however, the results obtained may be often falsified in consequence of phenomena of surfusion. Sulphur is soluble in the bisulphide of carbon, as obtained by exhausting the flowers of sulphur, solidifies at 114.3°, whatever the temperature at which it has been melted. In octohedric sulphur the point of solidification is highest when it has been melted at the lowest possible temperature. Prismatic sulphur behaves like insoluble sulphur, if obtained from it; but if subjected to repeated fusions and solidifications, its congealing point may be raised more than a degree.

ANTHRAPURPURINE.

TO produce purpurine from alizarine, F. de Lalande has patented the following process in France:—100 parts alizarine are heated with 100 of dry arsenic acid, and 1000 of sulphuric acid to 302° Fahr., till a sample taken out gives a deep red color with soda lye. He then dilutes with 30 parts of water, heats and filters. The residue is used for dyeing. Instead of arsenic acid may be used antimonic acid, peroxide of manganese, stannic acid. Or dry alizarine may be added to ten parts of refrigerated fuming sulphuric acid, or instead may be heated in water with chromate of potash or with sulphide of copper, chlorate of potash, and sand to 140° Fahr. for several days.

Rosenstiehl by the action of nitrous acid upon dry artificial alizarine obtained a coloring matter in yellow metallic scales. It dyes goods mordanted with alumina a yellow, and those mordanted with iron a reddish violet. The colors are brightened by boiling soap-lyes. The dyeing is performed best with distilled water, or with addition of acetate of lime. —*Reimann.*

MAGNETIC NATIVE PLATINUM.

A SPECIMEN of native platinum from Nischne-Tagilsk in the Urals has recently been analyzed by M. Terreil (*Bull. Soc. Chim. de Paris*). The amount of iron present, 8.2 per cent, which is by no means so large as that met with in other specimens from the same locality, indicates Fe Pt_3 as the formula representing the composition of the alloy. This specimen, however, is chiefly remarkable for the fact that nickel is found to accompany the iron, and to be present in an amount closely resembling that occurring in the majority of the meteoric nickel-irons. The percentage ratios of these metals alloyed with the platinum are:—

Iron — 91.6; Nickel — 8.4. Total — 100.

Copper, a metal invariably present in small quantities in meteoric iron, is an equally constant constituent of native platinum.

MELANOPHLOGITE AND AERINITE.

THESE are two new minerals described by Von Lasaulx in the *Jahrbuch für Mineralogie*. The former occurs in very minute cubes on the sulphur deposits of Girgenti, in Sicily, associated with coelestine, calcite, and quartz, the little cubes lying on the thin pellicle of quartz which generally encrusts the sulphur crystals. The mineral possesses the curious property, when heated, of becoming in turn yellow, green, blue, and black. According to Bettendorff's analysis it is a hydrated silicic acid; he found in it 86.5 per cent silica, water, and very small traces of iron oxide, lime, and strontia. The second mineral, the locality of which has not been clearly defined (it probably came from Spain), is of a beautiful celestial blue color, compact, in places somewhat scaly, and exhibits dichroism. It has a hardness between 2 and 3, a specific gravity of 2.4, and is a silicate of protoxide and peroxide of iron. This interesting specimen takes its name from its fine color.

CHARACTERISTICS OF EOSINE UPON STUFFS.

By M. R. WAGNER.

To distinguish eosin from saffranin and other coloring matters, the most striking reaction is its inverse transformation by debromization into fluorescein. Under the influence of sodium amalgam fluorescein is very readily recognized by its splendid uranium-green fluorescence of an extreme sensibility. But this reaction, indicated by M. Baeyer, requires a skilful hand. The following procedure is easy and certain. Collodion is colored by all the dyes derived from aniline, by Magdala red and alizarin; eosin, on the contrary, is immediately discolorized by collodion. To detect it upon a tissue a drop of collodion is sufficient; if the tissue is dyed with eosin or methyl-eosin a white spot is produced.—*Deutsche Industrie Zeitung.*

DYEING RECEIPTS.

Gold-yellow on Linen (11 lbs.).—Steep for three hours in a boiling beck of 17½ ozs. tannin, and dye in a fresh cold beck, with about 3½ ozs. aniline orange, otherwise known as phosphine.

Chrome Orange on Linen (11 lbs.).—Boil up 3½ lbs. sugar of lead in water with an equal weight of litharge till the sediment is white. Let settle, and steep the yarn in the clear hot liquid for an hour; take out and take through a cold beck made up of 17½ ozs. lime. Rinse slightly, and work in a cold beck of 17½ ozs. chromate of potash and the same weight of sulphuric acid for a quarter hour. Redden in a boiling beck with 8¾ ozs. lime, working for three minutes, and rinsing. If the redder shade is required, top in a fresh cold water, with ¼ oz. magenta.

Rose on Linen (11 lbs.).—Work in a boiling hot beck of 7 ozs. tannin and 3½ ozs. curd soap; add to the water the solution of 3½ ozs. tin crystals, and dye with ½ to ¾ oz. saffranine at 110 degs. Fahr.

Red on Linen (11 lbs.)—The yarn is boiled with 8¾ ozs. soda-ash and 2 lbs. 3 ozs. lime for five hours, rinsed and passed through a cold beck of 8¾ ozs. spirits of salts. Rinse again. Stir up 8¾ ozs. fresh chloride of lime in water, and steep the goods in the clear liquid for six or seven hours. When quite white rinse in cold water, take through dilute spirits of salt at ½ deg. B.; rinse and work in a boiling hot beck of 17½ ozs. tannin, and dye in a fresh beck at 167 degs. Fahr., with 1¾ oz. saffranine of a yellow tone. The tannin is to be of the best quality.

Claret on Cotton Yarns (11 lbs.).—Make up a beck with 17½ ozs. prepared catechu, and work the prepared yarn in it for one hour. Wring and steep for half an hour in a hot beck of 6¾ ozs. chromate of potash; take through cold water, and work for thirty minutes in a beck of 3½ lbs. sumac at 190 degs. Fahr. Then dye in a cold beck with 1¾ oz. magenta, take out, add to the beck 8¾ ozs. alum and the decoction of 2½ lbs. logwood. Enter again, work in the cold beck; lift and add according to shade from ½ to 1¾ oz. chromate of potash, re-enter and work. The color is now complete.

Light Mode Gray on Wool and Woollen Yarns (110 lbs.).—Boil for one hour with 8¾ ozs. alum, 5 lbs. 7 ozs. sulphate of soda, 17½ ozs. sulphuric acid, 1¾ oz. extract of indigo, and the same weight extract of orchil.

Lavender Blue on Wool (110 lbs.).—Boil for an hour with 2 lbs. 3 ozs. logwood, 4½ ozs. extract of indigo, 17½ ozs. orchil, 4½ ozs. alum, and the same weight of copperas.

Greenish Mode (Reseda) on Wool (55 lbs.).—Boil for 90 minutes with 13½ ozs. chromate of potash and the same weight of tartar; let cool in the flat, and dye by boiling for an hour with 8¾ ozs. fustic, and the same weight of logwood.

A Darker Shade of the same.—Prepare as above, and dye with 8¾ ozs. logwood, 17½ ozs. extract of indigo, and 4½ ozs. orchil.

Drab on Wool (110 lbs.).—Boil for one hour with 2 lbs. 3 ozs. logwood, 8¾ ozs. fustic, the same weight of camwood, the same of copperas, and the same of tartar.

Reddish Mode on Wool (55 lbs.).—Boil for one hour with 6 lbs. 9 ozs. fustic, 5 lbs. 7 ozs. catechu, 4½ ozs. chromate of potash, and 13 ozs. copperas.

Washing Silks for Re-dyeing.—Brush well, and lay the pieces of the dress on a table covered with clean paper. Mix 3¼ ozs. ox-gall and the same weight of ammonia in 9 ozs. warm water, and apply it with a sponge on both sides. Roll the silk while still damp on a wooden roller, avoiding all creases. Merino and woollen stuffs may be similarly treated.

Fast Black on Woollen Yarn (11 lbs.).—Boil for one hour with 4½ ozs. chromate of potash and the same weight of prepared tarter finely ground; rinse immediately, and let cool in the liquor, and dye with 6½ lbs. logwood, adding a little fustic according to shade, and 7 ozs. logwood. Boil for ¾ hour. After dyeing drain and take the yarns four times through the prepared beck; rinse, and then take three times through an old soda-beck. Rinse when the dyeing is complete.

Noisette on Cotton Yarn, in Six Shades (11 lbs.).—No. 1: Make up a beck with 86 pints of water at 68 degs. Fahr., with 4½ ozs. sumac and 1¼ oz. prepared catechu. Enter the goods, steep for an hour, take out and add 2¼ ozs. nitrate of iron to the beck, give 6 turns, and wring very well out. Make up a fresh beck at 86 degs. Fahr. with ½ oz. chromate of potash, give 6 turns, and then take through warm water. No. 2: The first beck of water as before is made up with 8¾ ozs. sumac and 2¼ ozs. prepared catechu. Let steep for an hour; take out and add 3½ ozs. nitrate of iron, re-enter, give 6 turns, and enter in a beck of 1 oz. chromate of potash at 86 degs. Fahr. No. 3: The first water is 86 degs. Fahr., and contains the decoction of 13 ozs. sumach, 4½ ozs. logwood, and 3¼ ozs. prepared catechu. Steep for an hour. Add 3¼ ozs. nitrate of iron, give ten turns, and take through a beck of 8¾ ozs. (?) of chromate of potash. No. 4: The first beck is made up with 17½ ozs. sumac, 8¾ ozs. logwood, and 4½ ozs. prepared catechu. Let steep for an hour. Add 4½ ozs. nitrate of iron, and give 10 turns, and take through a fresh beck of 2¼ ozs. chromate of potash at 86 degs. Fahr. No. 5: The first beck contains the decoction of 26 ozs. sumac, 17½ ozs. logwood, and 7 ozs. prepared catechu. Steep for an hour. Add 6¼ ozs. nitrate of iron, and give 10 turns. Take through a beck of 3¼ ozs. chromate of potash. No 6: 2 lbs. 3 ozs. sumac and the same weight of logwood make up the first beck. Add 9½ ozs. nitrate of iron, and take through a beck of 6¼ ozs. chromate of potash.—*Reimann.*

WATER WORKS, ANCIENT AND MODERN.

OUR illustrations are from a course of papers by E. H. d'Avigdor, delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

Figs. 1 to 8 refer to the Mödling Aqueduct of the Vienna Water Works; Fig. 1 is a side elevation; Fig. 2 a sectional plan of a pier; Fig. 3 a section of abutment; Fig. 4 a section on A B, Fig. 1; Fig. 5 a longitudinal section of pier and part of arches; Fig. 6 a section corresponding to the upper part of Fig. 4, but to a larger scale; Fig. 7 a section at C D, Fig. 1; and Fig. 8 a section at J K, Fig. 3.

The other figures refer to celebrated Roman aqueducts, as follows:

Fig. 9 shows a part of the Marcia Aqueduct; Fig. 10 the Julia and Tepula Aqueducts built over the Marcia; Figs. 11 and 12 the aqueduct at Segovia; and Fig. 13 the Claudia Aqueduct.

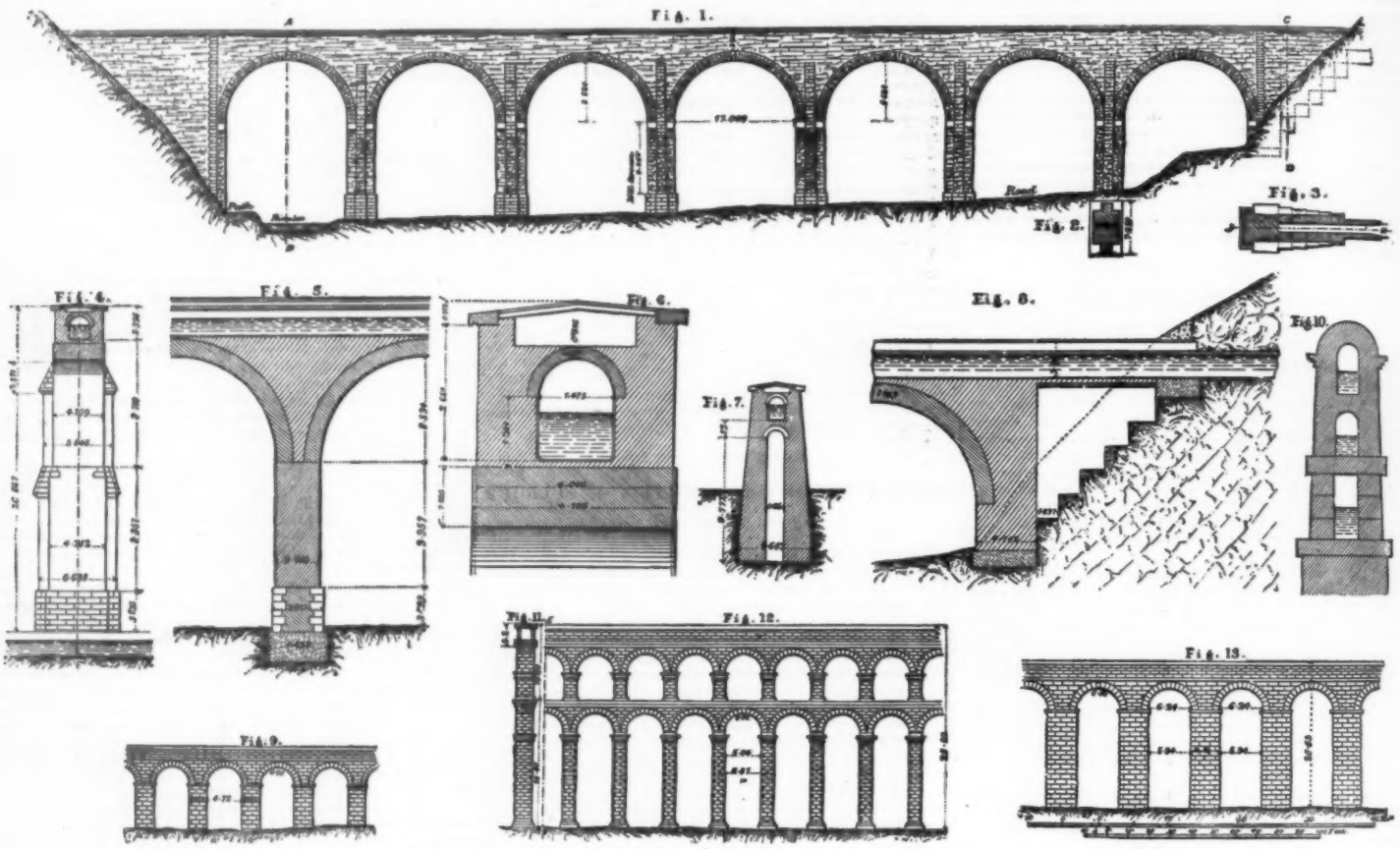
The ancient city of Rome was supplied by nine aqueducts, as given in the accompanying table, remains of some of which are still standing. The total length of the nine aqueducts, up to the walls of the town, was about 277 English miles. Of this enormous development about 31 miles were carried on arches. Most of the aqueducts crossed the volcanic plains near Roma Vecchia, after having kept to the hillsides as long as possible. Here the numerous ruins of the ancient Roman water works are still visible; here the visitor admires those rows of massive piers and splendid arches, many of them still in the same condition as when they were completed nearly 2000 years ago, notwithstanding Huns, Goths, Vandals, and Time itself. There is no settling, there are no cracks, no flaws, nothing except what is obviously the result of carelessness or intentional injury. The ashlar arches of Marcia are still patterns for the mason, while the hydraulic mortar is still so hard that the best Portland cement of the day will scarcely show a greater resistance to crushing. Above Tibur there is another point, the celebrated Valle degli Arci, where the four aqueducts which bring down the water from the limestone mountains all cross the valley on a series of beautiful arches.

I must now call your attention to some peculiarities of the lines and directions of the aqueducts, which have long puzzled antiquarians and engineers alike. Appia is the oldest aqueduct; Anio Vetus was the next constructed, and the rest were erected successively at the different periods indicated in Table I. Now, as in modern towns, so also in ancient Rome, it turned out that the old aqueducts did not supply the water at a sufficiently high level. The newer works were therefore invariably if possible constructed with their outfall higher than the old ones. This explains the curious fact, that two or three aqueducts were built one on the top of the other. This mode of construction was the more plausible, as the line from the hillsides to the very walls of Rome was indicated by nature itself by a low ridge. We find, therefore, that Tepula was built over Marcia, and 92 years later, Julia over Tepula (see Fig. 10).

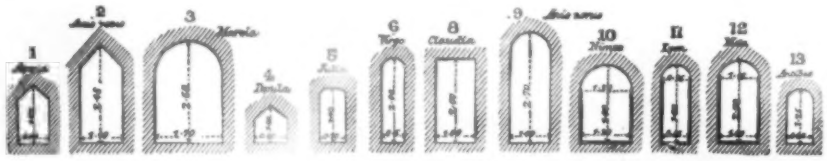
As to the cross-section of the aqueducts, the principal object of the Romans appears to have been to construct them sufficiently high inside to be easily accessible for repairs. They had no scientific data enabling them to fix the real cross-section required for a certain quantity, head of water and fall.

The Romans possessed three almost independent water services, for which they used water of different degrees of purity. The least clear and most loaded with sand, such as the Anio aqueducts supplied, was used for public baths and for watering the streets; the clearer water from Tepula and Alsietina served for tanks, fountains, and washing-troughs; while the very best (Virgo, Marcia, and Claudia) was confined to drinking purposes, and these springs were undefiled even after the heaviest rains.

As the Romans used three different sorts of water, the question naturally arises, whether they had three distinct services with mains, pipes, etc. In reality, however, they hardly possessed any proper service at all, at least none agreeing with our notions. The water of the aqueducts flowed through small "piscinæ," or tanks in which it deposited the heavier sand or gravel with which it was charged. It thus reached the Castella (water castles) or reservoirs near the city. They were of very moderate dimensions, and did not serve at all as supply reservoirs, but were only meant to distribute the water to the numerous smaller cisterns or towers, which were scattered all over the city at different places. These were circular cisterns



WATER WORKS ANCIENT AND MODERN.



ANCIENT WATER WORKS, REFERRED TO IN THE TABLE.

TABLE OF THE MOST IMPORTANT DATA OF THIRTEEN WATER WORKS OF ANCIENT TIMES, WITH THIRTEEN DIAGRAMS.

No.	Name.	Years of Construction.	Length in Kilometres.	Tunnel Length in Metres.	Arches Length in Metres.	Gradient per 1000.	Height above Sea Level.		Description of Ground.	Daily Flow in Millions of Gallons.	Remarks.
							Of Spring.	At Town.			
1	Appia	— 313	26.03	....	88.0	1.50	62	8.37	Volcanic plain	13.5	General use for watering streets, etc.
2	Anio Vetus	— 273	63.7	....	329	2.73	183	35.17	Limestone mountains	60	
3	Marcia	— 145	100.6	....	10.158	1.67	312	37.48	" "	21	Drinking water.
4	Tepula	— 126	18.8	....	610	1.55	?	38.23	Volcanic plain	0.5	" "
5	Julia	— 33	19.5	....	9.588	2.30	?	39.71	" "	10.0	" "
6	Virgo	— 19	25.2	800	1.037	1.54	70	10.43	" "	13.0	Purest water.
7	Alsietina	— 19	34.0	....	530	1.50	56	5.00	Lake	5.5	General use.
8	Claudia	+ 39	68.7	806	14.173	1.50	255	47.42	Limestone mountains	24.0	Drinking water.
9	Anio Novus	+ 40	86.9	802	13.023	3.00	250	48.12	" "	61	General use.
1—9	Aqueducts of Rome	....	443.4	2405	49.537	....	....	....		208.5	Rome and suburbs.
10	Nimes	+ 138	49.75	?	3.220	0.34	76	59.04	Limestone	6.5	Drinking water with modern siphons now in use.
11	Lyons (Pilatus)	+ 50	52.0	C^{a}/$_{10}$	C^{a}/$_{10}$	1.67	170	53.06		5.0	
12	Metz Restored	+ 130 ? 1854	22.166	....	....	....	....	....	Sandstone	9.3	
13	Antibes Restored	? +1777	6.0	4940	....	0.41	....	....	Sandy marl	0.6	Ditto.

N. B.—The dates marked (—) are before Christ; those marked (+) are after Christ.

Fig. 168.

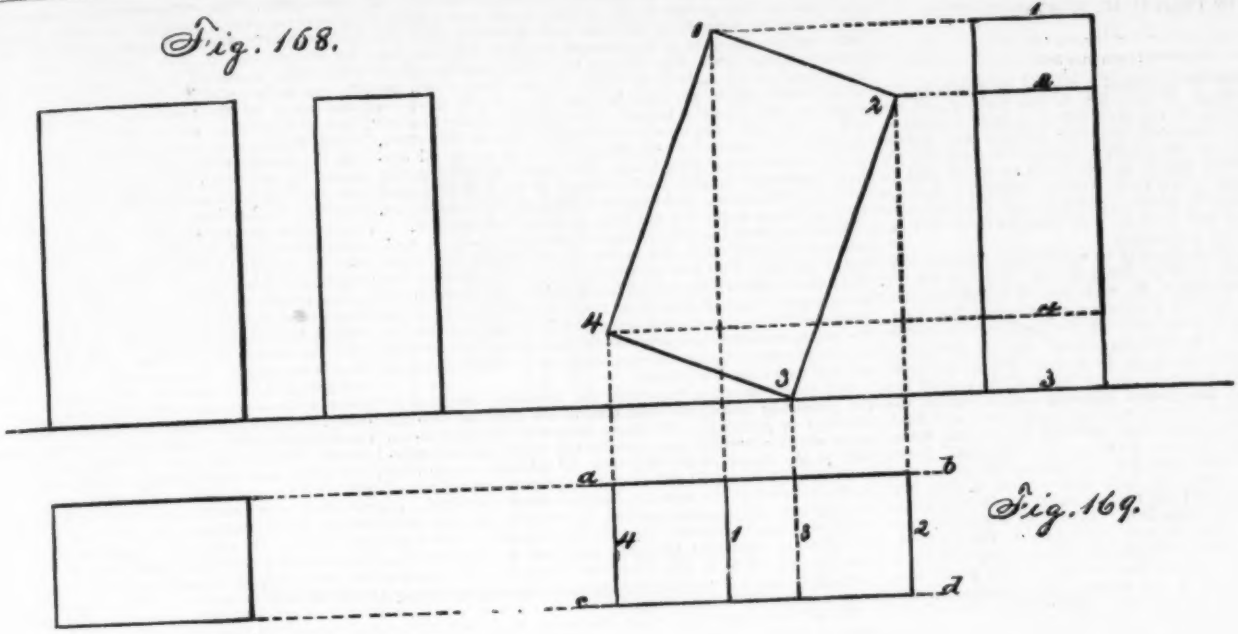


Fig. 169.

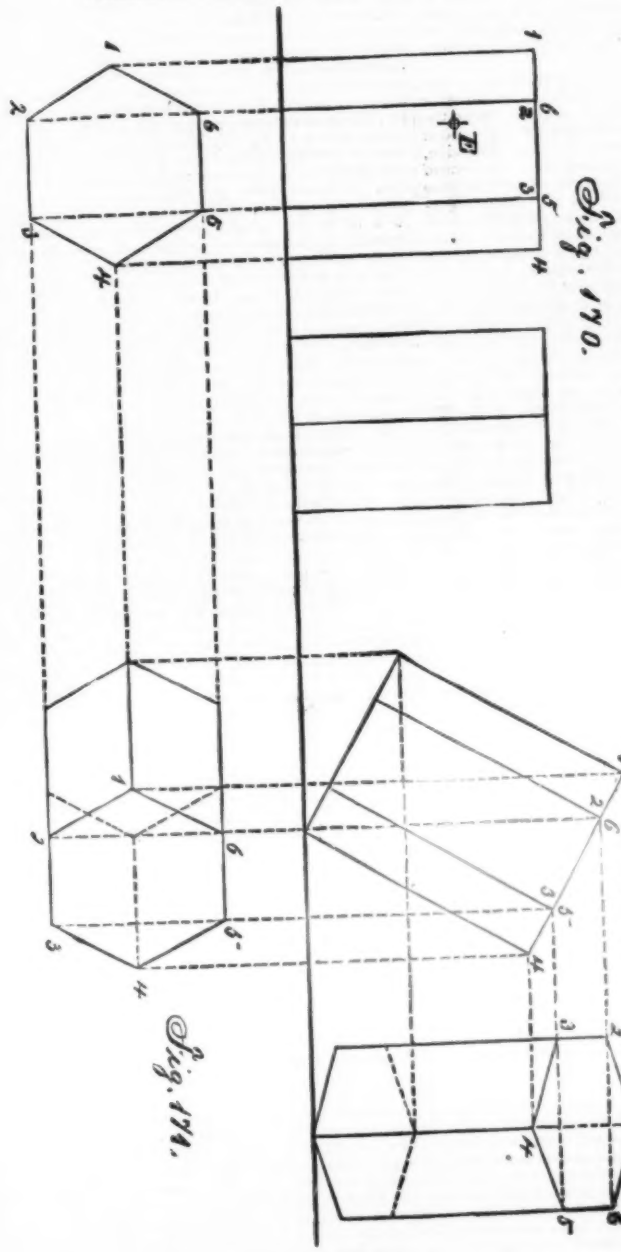


Fig. 170.

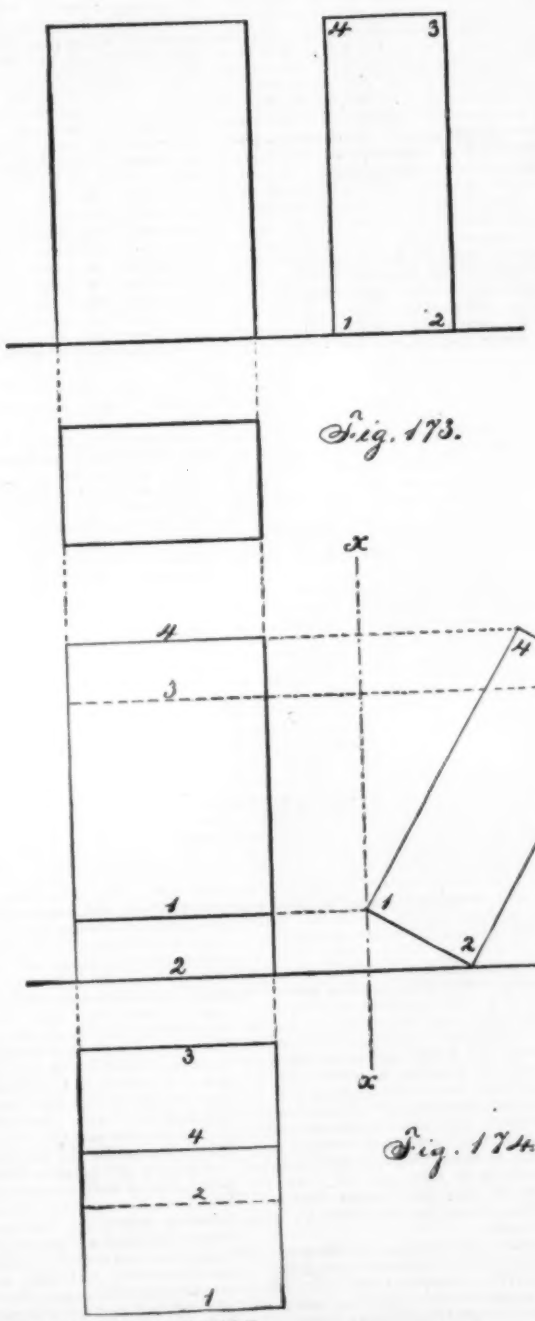


Fig. 173.

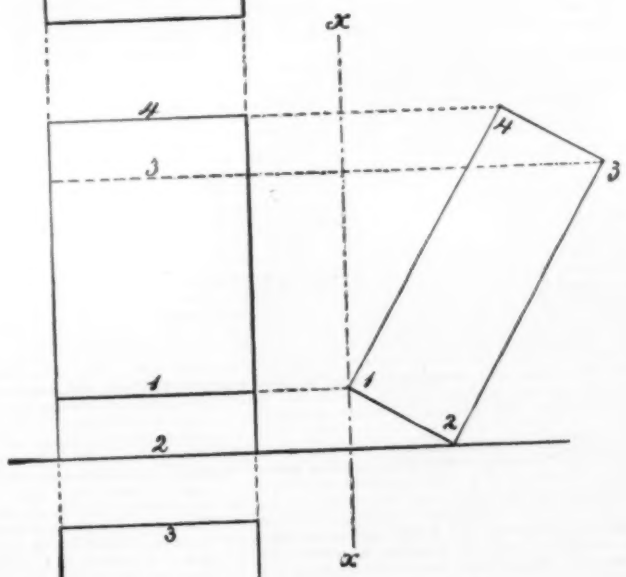


Fig. 174.

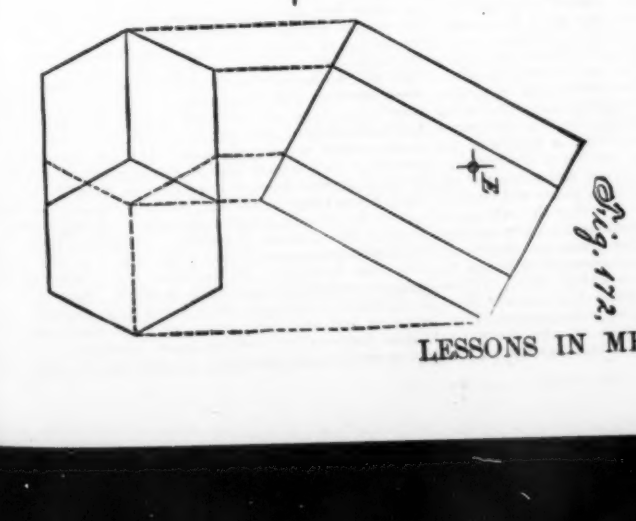


Fig. 171.

Fig. 172.

LESSONS IN MECHANICAL DRAWING.

By PROF. C. W. MACCORD.

No. XIX.

(Continued from page 588.)

IN the last lesson we explained a method by which, having given the projections of an object in one position, we can obtain the projections of the same object in another position. In the case there presented, the new position was derived from the original one, by simply twisting or turning the object round a vertical line as an axis; and we found that in doing this, the plan, or top view, was not changed in form or dimensions, but only in position, and also that the heights of the different points and lines, as seen from the front or from either side, remained unchanged.

Now the same principles may be applied in a different way, which we illustrate in Figs. 168 and 169. For the sake of simplicity and uniformity, we make use of the rectangular prism again, and Fig. 168 is merely a repetition of Fig. 144.

In Fig. 169 it will be noticed that the front view is exactly the same as in the first drawing, except that its position is changed. The difference is, as the student will at once realize by trial, exactly the same as if a block of the size of the drawing had been first placed standing on one end on the table, and then tilted over to the right, the front and back being still kept vertical, so that the block touches the table, not at one *corner* only, but all along the right-hand lower *edge*. This latter line, then, has not changed its position at all; and since the front and back were vertical at first, and are vertical now, he will see that no point of the object has changed its distance from him. But these distances from the observer are given, in our projections, in the top view. We see, then, that whatever is visible in the new top view must be included between the two horizontals *a b*, *c d*, whose distance from each other is the same as the thickness of the object as given in the original plan; and we have shown lines dotted across in extension of the lines at the front and back of that original, as indicating that in practice we may simply transfer these with the T-square, as we did the heights in the previous example, Figs. 164 and 165. Then with the triangle we have only to drop perpendiculars from the corners 1, 2, 3, 4, to find the positions of the corresponding lines in the new plan and complete the second view.

From these two, the third one is then to be constructed as before explained. The heights, though they are all different from those in the original drawing, except that of 3, are the same in the front and side views of the block in its new position, and the thicknesses being the same in the third view as in the second, the student should have no difficulty now in completing the construction.

We again beg the pardon of we hope all our readers for repeating that the amount of inclination, as well as its direction, selected in this operation, is entirely optional; that the block might have been tipped over to the left as well as to the right, and either more or less, and the third view might have been made from the left side too. And another thing: the object itself is fully explained in Fig. 168; so that Fig. 169 is wholly unnecessary as a working drawing. It is introduced merely to explain a mode of operation by which such a representation may be made when it is necessary—as, for instance, when the particular thing which is thus inclined forms only a part of a combination, the general drawing of which as a whole, in the position in which it is necessary or convenient to show it, will place this member in such an inclination.

All which we think it necessary to say, because we have met with very many who are so painfully literal in their acceptation of new information as to fall into the delusion that a complete mechanical drawing included representations of an object in all the different positions, in which they had been required to draw it for the sake of exercise in the application of the principles, and, worse than all, into the delusion that those positions were the only possible ones.

In the case which we have just been considering, the block in its second position, as we saw, stood upon an edge, and not upon a corner. And there is an occult process of reasoning, by which we have known the conclusion to be reached, that this too was a necessity, at least in all cases in which the object had any edges. Probably none of our readers will make that mistake; but the simplest means of guarding against it is to take an example in which it is not possible, in making the change now spoken of. A simple case of this kind is found in the hexagonal prism, shown in Fig. 170, in a position corresponding to that of the rectangular one in Fig. 168.

In Fig. 171 this same prism is shown, the inclination being like that in the previous case, in the sense that, while turning it over, the front and back faces are kept vertical and at the same distance from the observer. If the student needs a practical illustration, let him place a book upright on the table, and place his hexagonal pencil with its end also flat on the table, and one of its plane sides in contact with the front side of the book. He will then see it as in Fig. 170; then by turning it over to the left, still keeping its side in contact with the book, he will see it as in Fig. 171, and find that it can touch the table only on one corner and not along an edge.

Now, the steps of the process are precisely the same as those in the case of the rectangular prism—that is to say, having determined the direction and the angle of inclination, we copy the front view in the position thus determined, and in the top view each point is represented, as it always is, perpendicularly under its position in the front view, and in this case at the same distance from the observer as in the original plan. This the student will be enabled readily to trace out in the figures by the aid of the numbers 1, 2, 3, etc., which indicate corresponding points in all the views to which they are affixed.

We have in all these illustrations supposed that the object was placed upon a horizontal surface like that of a table, and that at least one point of it is kept in contact with that surface, however we vary the position or inclination of the object itself. But it is not necessary to suppose this; and we wish the reader to grasp this fact firmly, and not to associate the change of position with the absolute height of any one point, as measured from a fixed level. We suppose that by this time he is clear in his understanding of the fact that the front view is not changed in its appearance; which means that the points which are seen in that view do not change their relative positions; but they do change their relative heights and their relative distances as to right and left. All the points in the outlines, then, do absolutely change their positions in both these directions, except the one which we have supposed to remain on the table.

Evidently it could not make any difference in the result if we supposed that one to move also; which will be clear by the aid of Fig. 172. If in Fig. 170 we suppose a hole to be bored through the prism at E, perpendicular to the front and back faces, and a pin to be put through it and firmly driven into a board fixed behind, we might turn the prism about that pin until it had assumed the position shown in Fig. 172. In that case, all the points in the outline would have changed their absolute heights, as well as their distances right and left; and the amounts of the changes would be different, too, from what they are in Fig. 171; but the relative positions of all the points are the same in all three of these front views, and clearly these latter are alike in Figs. 171 and 172, except in regard to the absolute height. We introduced the illustration of the table only to aid in fixing the idea at the outset, and wish the reader to understand that it is not at all connected with the operation in any other way. In fact, it might have answered equally well, perhaps, if we had dispensed with that illustration, and supposed the model to be suspended by a pin upon which it could turn, as in the last instance.

What we wish the reader to see is, that the change in position here alluded to is accomplished by turning the object about an axis, which is perpendicular to the paper in the front view; that all the points in the object turn through the same angle, do not change their relative position, so that the view itself is not changed in form or dimensions, and that all the points preserve their original distances from the observer, for which reason the thicknesses, as given in either the top or the end views, are not altered.

And now comparing this with the operation described in the preceding lesson, we wish him to see that the two are identical in principle. We there supposed the object to revolve about a vertical axis—that is, one which is perpendicular to the paper in the top view, by which the top view itself was not changed; and as no point was raised or lowered by the revolution, the absolute heights were unaltered. In passing from the original position to either of the new ones which we have considered, then we find that one of the original views is merely to be copied, and that the dimensions, which are the same in the other two views, like the heights in the first case and the thicknesses in the second, are simply to be transferred without change.

We will now apply this to the remaining projection of our original drawing. In Fig. 173 we repeat Fig. 144 once more, in order to have the original group side by side with the new one, that the eye may at once see the relation between them.

We revolve the third view also about an axis, which in that view is perpendicular to the paper, by which the breadths, or distances from right to left, are not changed. Using the same illustration as before, it is as though, placing a book upon one end, and looking at it squarely from the front side, we were then to tilt it, either forward or backward, upon one of its lower edges. We should then see the whole of the front face as before, but it would not appear of its full size: the apparent height would be diminished, although the breadth would not be changed. In addition, we should see the whole of the upper face if we had turned it over toward us, the whole of the lower face if we had pushed the top away from us; but in either case, the face thus brought into view would be foreshortened, like the front one, to an extent depending on the angle of inclination.

The whole operation is distinctly shown in Fig. 174; having copied the view which is unchanged, we know that in the other two the breadths are the same as in the first group, and we draw the limiting parallels on the right and left accordingly: the heights are at once set across by the T square from the points 1, 2, 3, 4, which completes the front view. In the remaining, or top, view, the distances measured from us correspond to the horizontal distances measured from left to right in the one first copied. We therefore erect through the left hand point, 1, the perpendicular X X as a reference line; draw the line 1 in the top view at such a distance below the front view as to have a reasonable space between it and the top view when completed, and determine the distances at which the other edges, 2, 3, 4, will come by measuring horizontally across from X X to the points 2, 3, 4, in the first view.

ON FLY-WHEEL ACCIDENTS.

IN your SUPPLEMENT No. 30, of July 22d, you published a very sensible and interesting account of an accident to a fly-wheel, giving the full particulars of the affair, and very clearly pointing out the cause of the mishap.

We would be much pleased to see this practical and instructive article copied into every paper in this country, and the attention of engine builders, owners, and operators specially directed to it. They would learn from its perusal something of the requirements for and proper manner of constructing and operating wheels of this description; then, when so informed, accidents would be in a great measure avoided, and what Mr. Rose very properly calls "*barbarous construction*" and "*murderous workmanship*" would become unsalable and cease altogether. The bursting of fly-wheels has become so common that scarcely a week passes that we do not read of the mysterious peregrinations of this very useful but much abused accumulator and distributor of momentum. In this vicinity alone we hear of four fly-wheels having been destroyed within four weeks, and from what we have been able to learn of the causes assigned for the accidents, they could have been entirely avoided by the use of only ordinary precaution and a frequent inspection of the bolts and keys which held the parts together, and thereby time, money, and property would have been saved to the owners thereof.

About the first fly-wheel accident which the writer had any special interest in occurred in the State of Indiana, over twenty years ago. This wheel was 14 feet diameter, and weighed about 3½ tons, and was composed of a centre and six segments, each segment having an arm cast in the middle thereof. The ends of the segments were half checked, so as to overlap each other, and were cored out to receive three bolts; the holes were 1¼ inch, the bolts only ¾. The centre was cored out octagonal, and was secured to the shaft, also of the same section, by oaken and iron wedges, and the arms were each recessed into the centre and secured by three one-inch bolts; the holes were 1⅛ inch diameter. The entire wheel had not the least particle of fitting done to it, but was thrown together just as it came from the foundry. This wheel acted as a regulator to a 16 x 30 inch plain slide-valve engine, having a Judson governor and valve. The engine was employed in running a double circular saw-mill, and also in driving a grist-mill for grinding grain for the farmers in that section of the country. It had been in operation about six years, and when put up performed its work satisfactorily, but from abuse and neglect it had run down so as to be unable to do either the sawing or grinding separately. The owner concluded to have the machine overhauled and put in good shape again, and your correspondent was directed to make the necessary repairs and to put this wheezy, asthmatic motor in working order. When this was done the engine developed much more power than was required to drive both saw and grist mill together. This, unfortunately, through the carelessness of the operators, caused the destruction of the fly-wheel and the loss of two human lives. The writer warned the owner, miller, engineer, and sawyer, that if the abuse to which they were subjecting the machinery was not stopped, a serious accident would be the natural result. The grist-mill was driven by a shaft which was connected to the outer end of the main shaft of the engine by a clutch. The saw-mill was driven from a large band-wheel on the main shaft, and the saw was run by an idler, or tightening pulley, taking up the slack of the belt, which when not in operation ran loose on the pulleys. It was the practice of the miller to throw the clutch, which connected his mill with the engine, in or out as required, without checking up or notifying the engineer, and while under full headway. This sudden shock to the main shaft would for a moment arrest the speed of the engine, and throw a severe strain upon the arms of the wheel. The sawyer would also stop or start his saw without signalling or giving any warning to the engineer of his so doing. The engineer was also addicted to a very pernicious practice, and aided in a measure to the destruction of the wheel; for in stopping his engine he would unhook his rod and apply steam in an opposite direction to which the piston was moving. This was done to stop quick. Also in starting he would see-saw the piston backwards and forwards, and after doing so for a short time would run the piston up to nearly the end of the stroke, then hook up suddenly, and give full steam the reversed way. Thus each co-operated and aided the other in subjecting this misfitted and abused wheel to all the injurious shocks, sudden jars, and vibrations that they possibly could, so that its destruction was therefore inevitable. We also very emphatically pointed out the danger incurred in throwing off the work without signalling the engineer, as the engine had a full throttle and was controlled by the action of the governor; and if in doing so the governor belt should break or slip off, the engine would race, and very likely go through herself. But our advice was unheeded, and we were told that it had been their custom for years, and, as no accident had occurred, they felt safe and secure from any casualty of that kind. The murderous practices of the operators continued, and in less than three months thereafter the sawyer and miller relieved the engine of its load at the same time, and without notice, and in the temporary absence of the engineer. The result was as predicted. The speed of the engine was augmented, and at this critical moment the slack, flapping, neglected governor-belt came off the governor-pulley, the balls dropped, giving the engine a full opening of steam, which so greatly increased its already rapid motion that, in less time than I can relate it, the shackly old wheel was broken into fragments which were hurled in every direction. A piece of the rim with a part of the arm attached passed through the mill, cutting one of the main timbers 10 x 12 in two as though it were a match, and in its flight instantly killing one man and wounding another so badly that he never recovered from his injuries. This piece finally lodged in a field about 250 feet away from the engine. A piece of the wheel was found in the fly-pit; another struck the foundation-walls of the pit, tearing a large hole in the stone-work; several pieces went through the roof of the engine-room and mill, giving the place the appearance of having been bombarded with a battery of Parrott guns, clearly indicating a tremendous velocity of the different pieces, and the high rate of speed which the engine must have attained to have hurled them so far and with so much violence.

The result of an examination of the wreck soon after the accident determined that the wheel broke on the outward stroke of the engine, and this was also in the direction of the travel of the top of the wheel. The damage done to the engine was as follows: The main shaft was intact, and had been torn out of its bearings and carried with it the crank, connecting-rod, piston-rod and piston, and as much of the front cylinder-head as was equal to the diameter of the bore of the cylinder, the piston having operated against it like a large punch and just punched out a circular piece, which was found on the rod with stuffing-box and bolts complete. The remaining portion of the cylinder-head was left bolted to the cylinder. The cylinder-flange was fortunately much stronger than the head, otherwise the cylinder would have been destroyed; the piston-rod was bent, as was the connecting-rod; the rocker-shaft broken, eccentric strap fractured, and one of the main pillow blocks and the cap of the outer one destroyed. The governor-belt was found wrapped tightly around the main shaft, clearly indicating that it had slipped off before the accident, and had lapped on the shaft and wound up. The governor was carefully examined, and found to be in good order and perfectly free in its actions. Of the pieces of the wheel only about three fourths were ever found; the remainder was supposed to have lodged in a creek near the mill. The pieces all showed a bright abraded surface at the joints, both at the rim and in the centre. The bolt-holes were worn bright, as were the bolts, the latter much reduced in size where they rubbed in the wheel and under the head and on the face of the nut, showing plainly that the wheel was quite loose, and had been so for some time, which was a matter of no surprise: there being (first) loose, bad fitting, and (secondly) a constant abuse, and abrasion from said abuse, nothing less than a smash-up could be looked for. The bolts were brittle and highly crystallized, resembling in their fracture a piece of spelter more than they did a piece of iron. It is supposed that the bolts in the rim in one of the segments first gave way, thus allowing that piece to get out of place and destroy the equilibrium of the wheel, which, revolving at a high rate of speed, was immediately hurled with all the force and energy which was stored up in this revolving reservoir of momentum.

The foregoing, I think, plainly shows the causes which produced this disaster, and proves that the want of care in operating machinery is often productive of more harm than is the want of knowledge; for a careful, cautious, though ignorant operator is far safer than a practical, reckless, haphazard one. It should be made the duty of every engineer to make frequent examinations of all the machinery under his charge, and particularly should he examine the bolts and fastenings of the fly-wheel, and promptly take up any slack he might find in them. A good plan would be to tap every bolt with a hammer: the sound would indicate whether they were tight or not. In fitting up fly-wheels, all the joints should be faced up true and have a fair bearing, and all bolt-holes drilled and rimmed, with the bolts turned to fit snug in their respective places. If these simple precautions are taken, and regard had to concentricity or circular truth in erecting wheels, and if proportioned to their speed and duty, there need be no fear, even if the engine should run off, of the wheels going to pieces by centrifugal force; for in a stable wheel there is no risk. It is only when they lose their stability and some part gives way, and thus the balance lost, that fly-wheels are destroyed, or by some cause or attempt to suddenly arrest their motion. Cases of this latter kind are very frequent with small high-speeded machines, such as nut and bolt, spike, or rivet machines. It sometimes happens, in feeding those machines, that the nut, spike, or rivet last made has not left the die, and another is

fed in, and as there is no provision made for such an occurrence, the iron is jammed in between the dies, and something must give way or the fly-wheel rim leave its arms and falls off. Fly-wheel pumps labor under this disadvantage, especially if doing heavy duty. As sometimes a piece of wood or gravel will get under the suction-valve and hold it up, the engine loses its load and races, and often, when it has attained a high rate of speed, the obstruction will be removed, and the pump takes water when the piston strikes at a high speed a cylinder full of solid, non-elastic water, arresting its progress, while the fly-wheel, unable to stop, breaks to pieces by the force stored within itself. Any visitor to our old water-works can see quite a number of fly-wheels which were broken just as described. They belonged to two Eclipse pumps, used as auxiliaries to the main engines.

Some time ago we saw a first-class Wright's double-plunger pump completely wrecked, and the fly-wheel broken in pieces, by the abuse of the attendant. It failed to lift water as quickly as he desired, and so he ran it at about 300 revolutions per minute, when the pump took water, and jam! went the plunger against it, the fly-wheel broke, the air-vessel was torn off at the flange, and the pump-chamber split clean open, all through the recklessness of the maniac in charge. So we see that it is impossible to bring suddenly to a state of rest a body having the impulse of a fly-wheel of even moderate dimensions and speed without a smash-up being the result. In agricultural machines, notably straw and fodder cutters, there is an arrangement to overcome this difficulty, so that, in case any foreign substance should get in with the material to be cut, and jam the machine, no injurious result will follow; and it is a plan which might be applied to heavier machines with profit. The plan is as follows: On the fly-shaft is placed a fixed collar, having radial indentations in its face next the wheel. The wheel has similar corrugations on the face of its hub, and is loose on its shaft; immediately behind it is a gum collar, which serves as a spring to keep the wheel up and locked with the fast collar. The gum collar is set up by a nut and washer behind, and its tension is regulated so as to just drive the wheel when doing legitimate work, and when undue strain comes upon it the wheel crowds against the collar and runs loose on the shaft, and when the strain is removed it locks itself again without sustaining any injury.

Another accident, the cause of which might be partly attributed to the writer of this communication, resulted from oversight and want of thought in its construction, and by the bad judgment of the blacksmith who prepared the arms, and the moulder who placed them in the mould. The wheel was 9 feet diameter, with eight wrought-iron arms of 2 inches diameter, and weighed 3500 lbs. The rim, with the arms put in, was first cast, and when cool the hub was cast on the arms. It was for the driving-shaft of an 8-inch train of rolls, and was driven by an 18-inch belt, at 300 revolutions per minute. It was turned true and balanced, and to every appearance was a good wheel. It had been run constantly for about three months, when unexpectedly it broke, tearing away its foundation and pillow blocks, and breaking the shaft, which was of cast-iron and 8 inches diameter. A part of the wheel passed through a pine brace, 12 x 14, cutting it in two and splintering it all up, and finally falling in amongst a crowd of laborers who were piling up iron, fortunately without injury to any one. Upon examination, it only took half a look to discover the cause. The blacksmith who had prepared the arms, instead of upsetting the ends as he should have done and was ordered to do, at the suggestion of the moulder nicked or ragged the ends, and made the nicks diametrically opposite each other, and by so doing nearly cut the arms in two, and the highest nick in the arms was just enough under the surface to be hidden from view. The result was that from a little usage and vibration the arms loosened slightly in the casting, and finally one broke off, throwing the wheel out of true, and at the next revolution hurling it in pieces as aforesaid. Much more might be said and many illustrations given, but I will conclude this already very lengthy article by touching a little on the destruction of machinery through having wheels unbalanced. The most particular and most serious case of this kind occurred at a large match factory where I was temporarily employed. In some experiments in making match-splints, a large circular wheel was employed, having a number of cutters secured to its perimeter by set-screws and caps, and in addition, for safety, each set-screw had a jam nut. It took all the power of a 12 x 24 engine, making 80 revolutions, 120 lbs. boiler pressure, to run this wheel, which was 8 feet in diameter and made 800 revolutions per minute. The person running the wheel had just put in a new set of cutters, but unfortunately had left out one cutter, clamp, set-screw, and nut, the whole probably not over three pounds in weight. In starting up the wheel, he noticed an unusual shake and tremor, which increased as it got under headway, and before it could be stopped it shook the wheel all to pieces, scattering it in all directions, and shaking the building, so that it was with difficulty that some of the girls who were employed upstairs were prevented from jumping out of the third-story windows. The engine, in this case with a high pressure of steam, and the work thrown off so quickly, ran off, and, in consequence of there being several large unbalanced pulleys on the line shaft which were unable to stand that high speed, the whole line of four sections of 3-inch shaft was thrown to the ground a distance of 16 feet, bending the shaft and breaking the pulleys and the post-hangers which sustained it.

Now, Mr. Editor, I will say, in closing, that my experience and observation teaches me that there are three important points to be kept in view in regard to fly-wheels, namely: 1st. Proper proportion and design for the duty and speed required; 2d. The very best materials and workmanship, which of course includes concentricity and equilibrium; 3d. Care and a little common-sense in operating. T. B.

PITTSBURGH, August 14, 1876.

HIVING SWARMS IN HIGH TREES.

A WRITER to the *Gardener's Chronicle* writes: "I have used for some time for this purpose a bag made with stiff black leno, stitched. Around the mouth I attach a little very thick wire, to prevent it closing when being used; the bag is then fastened or nailed near the top of a long pole made of deal wood, about 9 feet in length and 2 inches in thickness, or like a clothes-prop, but at the summit, about 6 inches above the bag, I nail a bit of wood to prevent the pole from splitting, as well as to act as a hammer, to beat or shake the bough on which the swarm is settling. The illustration will explain it far better than a merely verbal description. To the wire ring, if desired—although it will act far better without—a string may be tied, and held in the hand of the operator, and, when the bees are shaken into the bag, by pulling the cord they are prevented from escaping. I make use of it thus: Having got it in readiness, when the bees are observed to begin clustering, of course the first thing to be attended to is the hive, and the table on which they are to be placed for a few minutes after hiving, before they are finally removed to their permanent stand. Then suddenly shake the bough with the end of the pole, the bees will drop into the bag—very few

will be left on the branch after a vigorous shake. Slowly bringing them down to the table, hold the bag for a few minutes beside the hive, which should be slightly raised on the side nearest the bees, to allow of free ingress. The bees, seeing a home in readiness, will not be long in taking possession of the new tenement. You need not fear securing the queen at the first shake, and if any of the bees are at all disposed to take refuge again on the bough, lay across it a smoking or smouldering rag, which will quickly drive away every bee to the hive below. The table should be placed beneath the tree, if possible. It will not take long to hive them in this easy way. I have succeeded in securing them, persuading them to settle in the new home, and removing them to the stand in fifteen minutes; in half an hour afterwards they have commenced working as if nothing had happened."

HORSE-POWER PUMP.

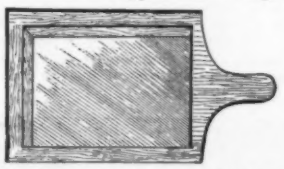
A SIMPLE arrangement for working pumps by horse-power is shown in our cut. It is the design of F. A. Hill, San Leandro, Cal. It consists of a centrally pivoted walking-beam, one end of which is connected with the pump-rod by a pitman, while the opposite end is connected with a crank wheel by a similar pitman. This crank wheel is secured upon the

end of a horizontal shaft, which is supported by a suitable standard near the wheel. The outer end of this shaft has a large traction wheel mounted on it, and the horse is hitched to the shaft near the traction wheel. As the horse travels around in a circular track, the traction wheel rotates and the motion is transmitted through the crank wheel, oscillating beam, and pitman to the pump rod.

CHEAP PHOTO PLATE-HOLDER.

By L. MACDONA.

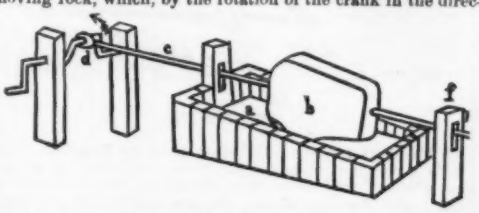
ALTHOUGH a great variety of plate-holders have, from time to time, been contrived, the following, from its simplicity and cheapness, may prove useful to your readers. A piece of half-inch pine is cut of same shape, but a half inch larger all round than the size of plate used; one end of which may be fashioned into a handle, as in the figure. Now get a carpenter to cut a "rabbet" a quarter inch deep, and one six-



teenth inch larger than the plate you wish it to hold; fix in this rabbet a glass plate, by means of marine glue or putty; give the holder a coat of shellac or paraffine, and you have a plate-holder possessing, amongst others, the following advantages: It allows the negative to be held up to the light without any fear of its falling off, adhering as it does to the glass by capillary attraction; the free silver, instead of being washed off by the developer, is retained on the plate and assists in increasing the density; less developer is used, and useless waste avoided; and last, but by no means least the fingers escape the slightest stain.—*Photographic News.*

A CHEAP ROCK BREAKER.

IN the engraving, *a* is an inclined table made of one or more pieces of rock, inclosed by a low wall of rocks or wooden lags. On the table rests a mass of rock *b*, which is connected by an iron rod, *c*, with the crank, *d*; another iron rod, *e*, also fastened into the rock, *b*, passes through a slot in the post, *f*. The ore to be broken is thrown upon the table in front of the moving rock, which, by the rotation of the crank in the direc-



tion of the arrow, is lifted and drawn forward over the ore. As the crank continues its rotation, the weight of the rock and the sliding movement imparted to it crush the ore beneath it and cause it gradually to work out at the lower end of the table, when it may be transferred to a pulverizing barrel, or sifted, and the coarser part reground in the machine. This is merely a suggestion, and improvement will doubtless be made by intelligent miners.—*Mining and Scientific Press.*

ELECTRICITY AS A MOTOR.

A RECENT lecture was given by Professor Carey Foster, F.R.S., at South Kensington, on "Electricity as a motive power." Dr. Siemens, F.R.S., took the chair. Professor Foster first showed with a number of experiments that by very simple arrangements light bodies can be moved by electricity. Indeed, the usual method of testing whether a body is electrified is to see if it is capable of producing motion. On this principle the electroscope and the galvanometer are founded. The way in which a bar of soft iron can be converted into a magnet by passing a current through a wire twisted around it was illustrated for the purpose of showing how the iron may be magnetized and demagnetized at will, and how, by arranging that this shall be done in an automatic way, it is possible to contrive continuous motion. A bar of iron suspended across the poles of a horseshoe-shaped mass of iron which can be magnetized and demagnetized at pleasure, can be made to revolve. If suspended at right angles to the poles, it will swing round to set with the poles, and if at this instant the iron be demagnetized, the bar, instead of setting, will swing on. By again at once magnetizing the iron the impetus of the bar is increased, and by repeating this rapid rotation may be secured. An apparatus based on this principle with cross magnets was shown at work, which had sufficient power to drive two small pumps lifting water. Some of Sir C. Wheatstone's apparatus, based on the same principle, were also exhibited. Professor Foster then went on to show where there was a loss of power. A magnet placed vertically on pivots was made to revolve by galvanic electricity. Then the magnet being set spinning with the thumb and finger was, by a galvanometer, shown to generate electricity, but of the opposite kind to that which had before set it turning, though its power was not so great. When a current then sets up a motion in a revolving magnet, the revolving magnet also sets up an opposing current. This was further illustrated by two gramme machines, which are used for converting mechanical motion into electricity. The two were united together and the motion of the turned handle of the first was converted into electricity, which, passing on to the second, manifested itself then as motion. The connection was then made through a platinum wire, and when the second machine was held so as to prevent motion, the wire became heated to redness. When the second machine was turned, giving a current against the first, the wire was further heated to whiteness.

Professor Foster gave the formula for calculating the effective force of a battery, calculating the inverse current set up. Although we can not say what remains to be invented, we can say that, so far as is at present known, there seems no reason to believe that electricity will be used as a practical motive power. There is always power lost by the inverse current. Work of some kind must be done to produce electricity, and this can be more economically done by employing that power directly. The cost of the coal to smelt an amount of zinc that would do a certain amount of work in a battery would be more economically spent on coal doing work directly in a steam-engine. We can not look with any hope to electricity to supersede steam.

CHUTAUX'S ELECTRO-MOTOR.

IN the Chutaux motor the armatures consist of several pieces of soft iron magnetically isolated one from the other, and capable of being increased in number, according to the construction of the motor. With but a small volume, a large surface is thus presented to the poles of the electro-magnets. The division of these armatures makes possible an instantaneous magnetization or demagnetization, no electricity remaining once the current is broken. A rapidity of motion is thus attained proportional to the rapidity of production of the electricity in its circuit. Contrary to the usage of other systems, in the present invention the induction-spark is divided at several points simultaneously. This preserves the commutator from wear on breaking the current; since, as the electro-magnets do not produce an attractive force proportional to the number of elements in the battery, the latter exceeds that which produces saturation, and in this case generates a spark which discharges the point of contact. The mechanism of the new electro-motor obviates these defects by passing into the circuits of each electro-magnet the current only of a battery, the force of which is below saturation. This current is divided, when interrupted, over several points at the same time, producing only a spark which can be supported by the contacts, without heating them. If it be necessary, for the production of a greater force, to employ several batteries, they all act individually and separately, producing a utilizable power proportional to the number of elements which compose the batteries. The action of the motor is reversible at will by the operation of a commutator interruptor.

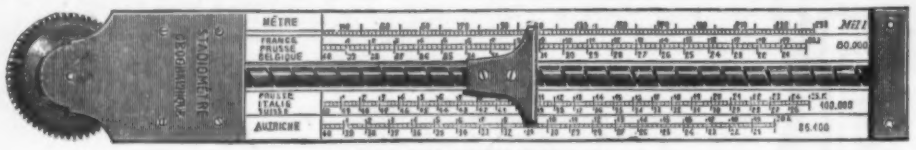
The battery is the subject of a separate patent. Its power, relatively to the Bunsen battery, is stated to be as 11,400 to 11,200. Its constancy is secured by mechanical means, which provide for constant renewal by the continual dropping in of fresh fluid stored at the upper part of the porous vessel. The waste produced by chemical action in the zinc cell is thus compensated, and there is no need to amalgamate the latter with mercury. Fragments of "gas carbon" are distributed in the porous cell: their unevenness gives a larger surface to the positive pole and diminishes the adherence of the bubbles which usually produce polarization The battery is stated to be of singular permanence and altogether inoffensive.

THE KEELY MOTOR.

MR. KEELY, a workingman in America, declares that by means of a machine which he has invented, he can, without the use of fuel, and by merely turning a handle, generate out of water a vapor so much more powerful than steam, that with a gallon of water he can drive a heavy train from Philadelphia to San Francisco; and with a hogshead he could impel a Cunard steamer from Liverpool to New York against a continuous westerly gale! The inventor, it is stated, has induced Mr. Collier, a patent solicitor, to examine into the matter, who was so struck with what he saw that he got a scientific man to verify it. Both agreed that Keely actually did produce extraordinary results, but they could not tell how these results were obtained. The Chief Engineer of the United States Navy, who witnessed the experiments, was equally assured that the thing was actually done, but equally at a loss to explain the doing of it. Mr. Collier then formed a company in New York. A small capital for carrying out the preliminary experiments was raised. Mr. Keely is said to have refused a cent until the world has been thoroughly convinced of the reality of his invention, and until patents have been secured in every country. Some of the American journals look upon the whole thing as a delusion.—*London Paper.*

THE GEOGRAPHIC STADIOMETER.

THIS instrument, devised by Captain Bellomayee, is designed to show at a single reading the measure of any line, right, curved, or broken, on maps or charts executed on any scale. The toothed wheel shown at the bottom is moved over the line and imparts motion to the longitudinal screw. This, in rotating, causes the ascent or descent of the carriage, the straight edge of which serves as an index.



GEOGRAPHIC STADIOMETER.

Eight scales are used, one of $\frac{1}{80000}$ for Prussian, French, and Belgian maps; one of $\frac{1}{100000}$ for Prussian, Italian, and Swiss maps; one of $\frac{1}{85400}$ and another of $\frac{1}{144000}$ for Austrian maps; two respectively of $\frac{1}{21000}$ and of $\frac{1}{42000}$ for Russian maps; one of $\frac{1}{63360}$ for English maps, and finally a graduation corresponding to the natural metric scale. This last marking by a simple reduction allows of the instrument being used for maps constructed on any other scale than those mentioned.

The device is held in the hands like a pencil, and as the wheel runs over the line it is only necessary to read the distance travelled on the proper scale to know the exact length of the line. When the index reaches the top of the screw, the instrument is turned around and pushed forward as before—the marking being now read from the top downward instead of in the reverse direction. It is especially useful in the field for military operations, as it does not require the entire map to be spread out flat before it can be used. It of course obviates the employment of dividers, and the usual scale of distances printed on charts.

ELECTRICAL VORTICES.

FROM observations made on the escape of steam from kettles and railway engines, and of smoke from tobacco pipes and cannon, I was led to believe that many of the evolutions performed by the discharged vapors arose from their being in a different electric condition to that of the surrounding media, that they were in a spheroidal state, that the rings and various forms of radiation they assumed were due to this condition, and that the particles of vapor and smoke were involved in electric vortices.

MR. Robert Hunt's experiments on the influence of magnetism on molecular arrangement* favor this view; and, as they are important and may not be readily accessible to some of our readers, the following extract may perhaps be admissible:

FIG. 1

FIG. 2

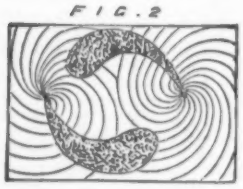
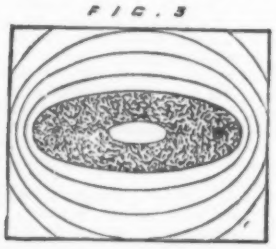


FIG. 3



"12. A plate of copper with an edging of wax was placed on the electro-magnet, over it a very weak solution of nitrate of silver was quickly poured; the plate immediately blackened from the decomposition of the silver salt by the copper. In about a minute the finely-divided silver arranged itself into curves as represented in Fig. 1, which were after a few minutes again destroyed. By using a sheet of chemically pure copper obtained by electrotype deposit I found a permanent impression of these curves could be obtained, owing to the oxidation of the copper along the spaces, which the finely-divided silver, when distributed in curved lines, did not occupy.

"13. A plate of hard copper, such as is used by engravers, was placed in precisely the same circumstances and covered with a tolerably strong solution of nitrate of silver. It was left in contact with the electro-magnet for a night. On washing off the deposit of silver which covered it, it was found that the acid of the silver salt had bitten deeply into the plate over an oval space around the poles, leaving a small space between them quite bright. The copper over this etched space was covered with an immense number of minute holes, and, beyond this, the oxidation of the surface had proceeded in curved lines, as represented in Fig. 2. We thus have permanent evidence of the influence of magnetic force in determining chemical action.

"14. Into one of the glass troughs before named—a plate of glass with an edge of clay—placed on the electro-magnet, a weak solution of sulphate of silver was poured, and into this an equally weak solution of sulphate of iron. In about five minutes precipitation of silver commenced. This precipitate arranged itself over the glass in curves from and around the poles in the same manner as it distributed itself over the copper plate. In a short time, precipitation increasing, two curious curved spaces were formed by the fine deposit, proceeding from one pole towards the other in opposite directions, increasing in width as they proceeded, until they were abruptly checked at a little distance from the poles towards which they were directed, these spaces being very distinct from the first formed curved lines. Fig. 3 represents this."

Thus far as regards the effects of electro-magnetism on chemical action in progress. But there seemed something wanting between it and the effects of the poles of an electro-magnet on loose particles of matter not immediately involved in chemical action. Whilst I was studying a means for supplying this want, M. Gaston Planté's very simple and ingenious experiments were made known, which meet what is required. It is unnecessary to repeat them here, as they have been already noticed in these columns.*

These experiments indicate most distinctly the existence of electric vortices. In M. Planté's experiment the fluid passing from the electrode involves the metallic particles and renders the vortex visible. The explanation I gave twenty-seven years ago of the behavior of the electric fluid when passing along a wire † shows that it arises from the latitudinal and longitudinal action of the fluid upon itself, owing to which it moves corkscrew fashion, the principle involved being that of two forces propelling a body on the diagonal of the direction of those forces. The paper referred to was an explanation of the cause of the magnetic needle assuming its peculiar position in Ampère's experiments when a current is passed along a wire. This paper would not admit of being abstracted, and would seem too long to insert here. But M. Planté's experiments confirm what was there said, and show the current passing off into loose and liquid materials, continuing, as far as these can hold together, the vortex established on the wire.

This is very noticeable when he illustrates the formation of waterspouts, producing in a mixture of salt and water similar gyrations to those witnessed in that meteoric phenomenon, and showing the tendency of the liquid to rise in the vortex. The direction of gyration in these experiments is also found to agree with that of waterspouts in nature, the reversal of the experimental electric current changing the direction of gyration, as waterspouts revolve in opposite directions in the two hemispheres, which M. Planté considers may be attributed to the flow of the electric fluid under the magnetic influence of the globe.‡

Another form of vortex appears in M. Planté's experiments. The immersion of the positive wire into a liquid conductor, such as salt water, determines the aggregation of the aqueous molecules about the electrode in the form of a luminous spheroid in consequence of a double simultaneous effect of flowing and suction—*d'écoulement et d'aspiration*—"or of transport in the two directions that seems peculiar to the electric fluid." §

The whole universe develops vortices or centres of force *en rapport* with electricity. Amongst animals it appears in the ganglions and other nerve-centres; in the vegetable world in the deposition of cells, in the roots, the joints, the corollæ, and the fructification; and in the inorganic world in every centre of chemical change; in the planets, in the solar system, in the Milky Way, and those still more distant centres, the casual messengers from which occasionally visit our system.—JOHN J. LAKE, in *English Mechanic*.

* *Philosophical Magazine*, third series, Vol. XXVIII., page 1.

THE AGOUTI.

THIS little animal is a rodent, peculiar to South America. It has been compared to the hare or the rabbit, and has some resemblance to the guinea-pig. The length of its body is about a foot and a half, that of its tail less than an inch.

THE AGOUTI.

Its hind-legs are so much longer than the fore-legs, that it finds the descent of any declivity very difficult. Its flesh as an article of food is by some considered palatable and delicate; and, for this reason, the question of its acclimation is discussed in France. That this may be done has been shown by the breeding of the animal at the Zoological Gardens in Antwerp and Paris. It is proposed with the agouti to replace the rabbit and the hare, which are becoming every year more rare in France.

The characteristics of the agouti are described by Dr. Brehm. The little creature is called the golden hare, on account of its beautiful robe. The hairs on the face and limbs are short, but longer on the lower sides and towards the hind-quarters of the animal; especially on the thighs, where the hairs are about three inches long. The throat is naked. The hair is shining and thick, stiff, and almost like lustrous silk in appearance; but the hues of the coat change with the angle of sight as the animal changes his position, or the hairs are long or short. Three or four rings of a deep brown alternate with rings of a reddish yellow or orange color, and their hue is deep or light as the fur is long or short. The orange tint predominates on the head and along the back, and changes with the seasons, being deeper in winter than in summer.

While the French are talking of acclimatizing this lively little rodent, the inhabitants of the countries where it is indigenous would be very glad to banish the animal, since it is very destructive to young plantations. The kangaroo, the introduction of which into France is also spoken of, is a formidable enemy to Australian farmers.

* *English Mechanic*, January 28th, 1876, p. 497.
† *Mining Journal*, May 8th, 1849.
‡ "Peut être attribue à l'ecoulement du flux electrique sous l'influence magnetique du globe."—*Comptes Rendus*, tom. 82, p. 222.
§ *Comptes Rendus*, tom. 81, p. 616; tom. 82, p. 214.

NEW SPONGE, FROM YUCATAN.—GENUS LUFFARIA.

THE ROWTON SIDERITE.

"AN addition of exceptional interest has recently been made to the collection of meteorites in the British Museum, by the presentation, on the part of the Duke of Cleveland, of a siderite (iron meteorite) which fell on his Grace's property at Rowton near Wellington, in Shropshire, about seven miles north of the Wrekin, on the 20th of April last. At about twenty minutes to 4 o'clock on the day mentioned, a strange rumbling noise was heard in the atmosphere, followed almost instantaneously by a startling explosion resembling a discharge of heavy artillery. There was neither lightning nor thunder, but rain was falling heavily, the sky being obscured with dark clouds for some time both before and after the incident narrated. About an hour after the explosion, Mr. George Brooks, stepson of Mr. Bayley, had occasion to go to a turf field in his occupation adjoining the Wellington and Market Drayton Railway, about a mile north of the Wrekin, when his attention was attracted to a hole cut in the ground. Probing the opening with a stick, Mr. Brooks discovered a lump of metal of irregular shape which proved to be a meteorite weighing 7¾ lbs. It had penetrated to a depth of eighteen inches, passing through four inches of soil and fourteen inches of solid clay down to the gravel—conclusive evidence of the force of its impact with the earth. The hole (which has been protected for further investigation) is nearly perpendicular, and the stone appears to have fallen in a south-easterly direction. Some men were at work at the time within a short distance, and they, together with many other people in the neighborhood, heard the noise of the explosion."

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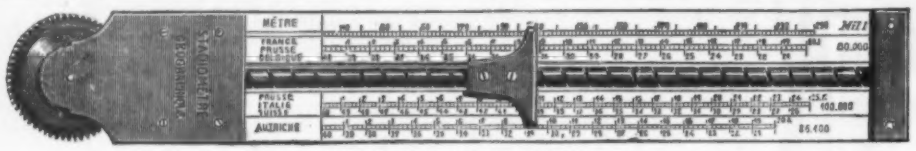
THE GEOGRAPHIC STADIOMETER.

THIS instrument, devised by Captain Bellomayee, is designed to show at a single reading the measure of any line, right, curved, or broken, on maps or charts executed on any scale. The toothed wheel shown at the bottom is moved over the line and imparts motion to the longitudinal screw. This, in rotating, causes the ascent or descent of the carriage, the straight edge of which serves as an index.



GEOGRAPHIC STADIOMETER.

Eight scales are used, one of $\frac{1}{2500}$ for Prussian, French, and Belgian maps; one of $\frac{1}{1250000}$ for Prussian, Italian, and Swiss maps; one of $\frac{1}{2500}$ and another of $\frac{1}{1440000}$ for Austrian maps; two respectively of $\frac{1}{21000}$ and of $\frac{1}{4200000}$ for Russian maps; one of $\frac{1}{63360}$ for English maps, and finally a graduation corresponding to the natural metric scale. This last marking by a simple reduction allows of the instrument being used for maps constructed on any other scale than those mentioned.

The device is held in the hands like a pencil, and as the wheel runs over the line it is only necessary to read the distance travelled on the proper scale to know the exact length of the line. When the index reaches the top of the screw, the instrument is turned around and pushed forward as before—the marking being now read from the top downward instead of in the reverse direction. It is especially useful in the field for military operations, as it does not require the entire map to be spread out flat before it can be used. It of course obviates the employment of dividers, and the usual scale of distances printed on charts.

ELECTRICAL VORTICES.

FROM observations made on the escape of steam from kettles and railway engines, and of smoke from tobacco pipes and cannon, I was led to believe that many of the evolutions performed by the discharged vapors arose from their being in a different electric condition to that of the surrounding media, that they were in a spheroidal state, that the rings and various forms of radiation they assumed were due to this condition, and that the particles of vapor and smoke were involved in electric vortices.

Mr. Robert Hunt's experiments on the influence of magnetism on molecular arrangement * favor this view; and, as they are important and may not be readily accessible to some of our readers, the following extract may perhaps be admissible:

FIG. 1

FIG. 2

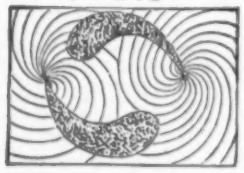
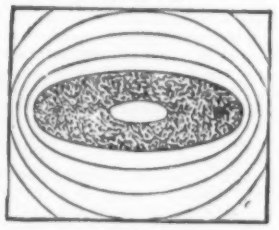


FIG. 3



"12. A plate of copper with an edging of wax was placed on the electro-magnet, over it a very weak solution of nitrate of silver was quickly poured; the plate immediately blackened from the decomposition of the silver salt by the copper. In about a minute the finely-divided silver arranged itself into curves as represented in Fig. 1, which were after a few minutes again destroyed. By using a sheet of chemically pure copper obtained by electrotype deposit I found a permanent impression of these curves could be obtained, owing to the oxidation of the copper along the spaces, which the finely-divided silver, when distributed in curved lines, did not occupy.

"13. A plate of hard copper, such as is used by engravers, was placed in precisely the same circumstances and covered with a tolerably strong solution of nitrate of silver. It was left in contact with the electro-magnet for a night. On washing off the deposit of silver which covered it, it was found that the acid of the silver salt had bitten deeply into the plate over an oval space around the poles, leaving a small space between them quite bright. The copper over this etched space was covered with an immense number of minute holes, and, beyond this, the oxidation of the surface had proceeded in curved lines, as represented in Fig. 2. We thus have permanent evidence of the influence of magnetic force in determining chemical action.

"14. Into one of the glass troughs before named—a plate of glass with an edge of clay—placed on the electro-magnet, a weak solution of sulphate of silver was poured, and into this an equally weak solution of sulphate of iron. In about five minutes precipitation of silver commenced. This precipitate arranged itself over the glass in curves from and around the poles in the same manner as it distributed itself over the copper plate. In a short time, precipitation increasing, two curious curved spaces were formed by the fine deposit, proceeding from one pole towards the other in opposite directions, increasing in width as they proceeded, until they were abruptly checked at a little distance from the poles towards which they were directed, these spaces being very distinct from the first formed curved lines. Fig. 3 represents this."

Thus far as regards the effects of electro-magnetism on chemical action in progress. But there seemed something wanting between it and the effects of the poles of an electro-magnet on loose particles of matter not immediately involved in chemical action. Whilst I was studying a means for supplying this want, M. Gaston Planté's very simple and ingenious experiments were made known, which meet what is required. It is unnecessary to repeat them here, as they have been already noticed in these columns.*

These experiments indicate most distinctly the existence of electric vortices. In M. Planté's experiment the fluid passing from the electrode involves the metallic particles and renders the vortex visible. The explanation I gave twenty-seven years ago of the behavior of the electric fluid when passing along a wire † shows that it arises from the latitudinal and longitudinal action of the fluid upon itself, owing to which it moves corkscrew fashion, the principle involved being that of two forces propelling a body on the diagonal of the direction of those forces. The paper referred to was an explanation of the cause of the magnetic needle assuming its peculiar position in Ampère's experiments when a current is passed along a wire. This paper would not admit of being abstracted, and would seem too long to insert here. But M. Planté's experiments confirm what was there said, and show the current passing off into loose and liquid materials, continuing, as far as these can hold together, the vortex established on the wire.

This is very noticeable when he illustrates the formation of waterspouts, producing in a mixture of salt and water similar gyrations to those witnessed in that meteoric phenomenon, and showing the tendency of the liquid to rise in the vortex. The direction of gyration in these experiments is also found to agree with that of waterspouts in nature, the reversal of the experimental electric current changing the direction of gyration, as waterspouts revolve in opposite directions in the two hemispheres, which M. Planté considers may be attributed to the flow of the electric fluid under the magnetic influence of the globe.‡

Another form of vortex appears in M. Planté's experiments. The immersion of the positive wire into a liquid conductor, such as salt water, determines the aggregation of the aqueous molecules about the electrode in the form of a luminous spheroid in consequence of a double simultaneous effect of flowing and suction—*d'écoulement et d'aspiration*—"or of transport in the two directions that seems peculiar to the electric fluid." §

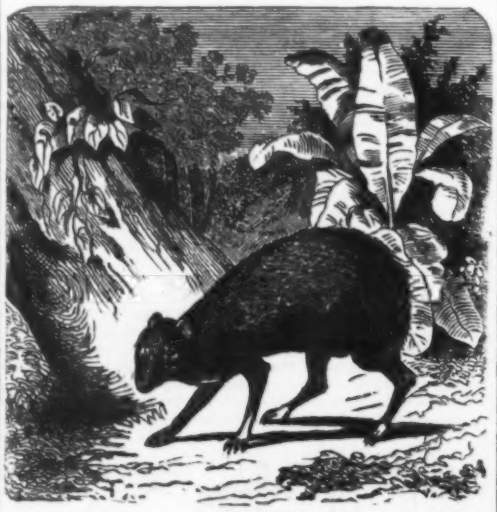
The whole universe develops vortices or centres of force *en rapport* with electricity. Amongst animals it appears in the ganglions and other nerve-centres; in the vegetable world in the deposition of cells, in the roots, the joints, the corollæ, and the fructification; and in the inorganic world in every centre of chemical change; in the planets, in the solar system, in the Milky Way, and those still more distant centres, the casual messengers from which occasionally visit our system.—JOHN J. LAKE, in *English Mechanic*.

* *Philosophical Magazine*, third series, Vol. XXVIII., page 1.

* *English Mechanic*, January 28th, 1876, p. 497.
† *Mining Journal*, May 5th, 1849.
‡ "Peut être attribue à l'ecoulement du flux electrique sous l'influence magnetique du globe."—*Comptes Rendus*, tom. 82, p. 222.
§ *Comptes Rendus*, tom. 81, p. 616; tom. 82, p. 314.

THE AGOUTI.

THIS little animal is a rodent, peculiar to South America. It has been compared to the hare or the rabbit, and has some resemblance to the guinea-pig. The length of its body is about a foot and a half, that of its tail less than an inch.



THE AGOUTI.

Its hind-legs are so much longer than the fore-legs, that it finds the descent of any declivity very difficult. Its flesh as an article of food is by some considered palatable and delicate; and, for this reason, the question of its acclimation is discussed in France. That this may be done has been shown by the breeding of the animal at the Zoological Gardens in Antwerp and Paris. It is proposed with the agouti to replace the rabbit and the hare, which are becoming every year more rare in France.

The characteristics of the agouti are described by Dr. Brehm. The little creature is called the golden hare, on account of its beautiful robe. The hairs on the face and limbs are short, but longer on the lower sides and towards the hind-quarters of the animal; especially on the thighs, where the hairs are about three inches long. The throat is naked. The hair is shining and thick, stiff, and almost like lustrous silk in appearance; but the hues of the coat change with the angle of sight as the animal changes his position, or the hairs are long or short. Three or four rings of a deep brown alternate with rings of a reddish yellow or orange color, and their hue is deep or light as the fur is long or short. The orange tint predominates on the head and along the back, and changes with the seasons, being deeper in winter than in summer.

While the French are talking of acclimatizing this lively little rodent, the inhabitants of the countries where it is indigenous would be very glad to banish the animal, since it is very destructive to young plantations. The kangaroo, the introduction of which into France is also spoken of, is a formidable enemy to Australian farmers.

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